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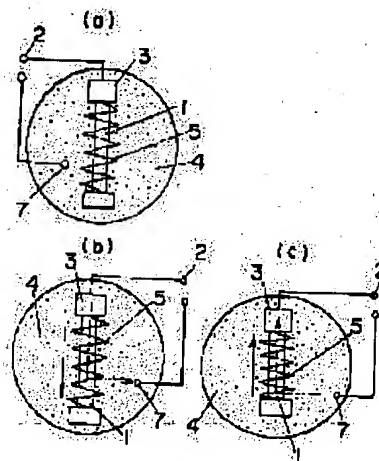
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(54) ACTUATOR

(57)Abstract:

PROBLEM TO BE SOLVED: To provide with a simple configuration an actuator capable of sure demonstrating ability as an actuator, even at expansion.

SOLUTION: An actuator consists of an expansion/contraction element 1 that is made of a π -conjugated macromolecular material such as polyaniline and polypyrrole, a power supply part 2 and a voltage application part 3 for applying a voltage to the expansion/contraction element 1, and an electrolyte 4 for conducting electricity from the expansion/contraction element 1 to the outside, and then is provided with a mechanism for causing the expansion/contraction element 1 to expand and contract, when positive potential and negative potential are applied to the voltage application part 3, respectively. The expansion/contraction element 1 is provided with a bias mechanism 5 such as a spring for generating force in the expanding direction on expansion. The power supply part 2 for supplying potential to the voltage application part 3 can vary switching between positive potential and negative potential and controls the amount of expansion/contraction of the expansion/contraction element 1 by switching the absolute value and the polarity of a voltage value.



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CLAIMS

[Claim(s)]

- [Claim 1] The flexible component which consists of pi conjugation mold polymeric materials, such as the poly aniline and polypyrrole. It consists of the power supply section for impressing an electrical potential difference to this flexible component and the electrical-potential-difference impression section, and the electrolyte for making it flow through a current outside from a flexible component. In the device which a flexible component will elongate if electropositive potential is impressed to the electrical-potential-difference impression section, and a flexible component will contract if electronegative potential is impressed to the electrical-potential-difference impression section. The power supply section which establishes bias devices, such as a spring which generates the force, in the elongation direction, and supplies potential to the electrical-potential-difference impression section at the time of elongation of a flexible component is an actuator which the change of forward potential and negative potential is adjustable, and is characterized by controlling the amount of telescopic motion of a flexible component by the absolute value of an electrical-potential-difference value, and polar change.
- [Claim 2] The actuator according to claim 1 characterized by enclosing an electrolyte with the space which installs the counterelectrode section in the electrical-potential-difference impression section, a flexible component, and its near, forms the covering sections, such as silicon, in the outermost periphery, and is formed between the counterelectrode section and a flexible component, and growing into it.
- [Claim 3] The actuator according to claim 1 or 2 characterized by coming to install the counterelectrode section in the perimeter of a flexible component.
- [Claim 4] The actuator according to claim 1 to 3 which installs the counterelectrode section in the electrical-potential-difference impression section, a flexible component, and its near, and is characterized by the counterelectrode section being the network structure.
- [Claim 5] The actuator according to claim 1 characterized by installing the electrical-potential-difference impression section in the both ends of a flexible component, and performing electrical-potential-difference impression from a power supply section from the both ends of a flexible component.
- [Claim 6] The actuator according to claim 1 characterized by the contact of the electrical-potential-difference impression section and a flexible component being larger than the electrical conductivity of a flexible component.
- [Claim 7] The actuator according to claim 1 to 3 characterized by installing the counterelectrode section in the electrical-potential-difference impression section, a flexible component, and its near, for the bias device carrying out the shape of coiled spring; and this bias device serving as the counterelectrode section.
- [Claim 8] The actuator according to claim 1 characterized by for the covering section which covers the outermost periphery having consisted of elastic bodies, and serving as a bias device.
- [Claim 9] The actuator according to claim 1 which installs the counterelectrode section in a core, makes the thin-film-ized flexible component the shape of a roll, and is characterized by arranging and growing into the perimeter of the counterelectrode section.
- [Claim 10] The actuator according to claim 9 characterized by the thing of the flexible component which carried out the shape of a roll for which the counterelectrode section is arranged so that a periphery may be surrounded further.
- [Claim 11] The actuator according to claim 10 characterized by arranging the flexible component which carried out the shape of a roll, and the two or more layers counterelectrode section.
- [Claim 12] The actuator according to claim 1 or 4 characterized by the actuator which arranged the flexible component which carried out the shape of a roll, and the counterelectrode section in the direction of a path carrying out the shape of a tube.
- [Claim 13] The actuator according to claim 1 characterized by impressing a negative electrical potential difference to the flexible component of another side when a forward electrical potential difference is impressed to a flexible component so that one side may contract in while, in case one pair of flexible component is prepared and one side develops for the flexible component of this pair.
- [Claim 14] The actuator according to claim 1 or 13 characterized by installing a flexible component in the both sides of the elastic core material from which the natural condition became a curve configuration.
- [Claim 15] The actuator according to claim 1 or 13 characterized by installing a flexible component in both the outsides of the elastic core material of the shape of direct [of a center section].
- [Claim 16] The actuator according to claim 15 characterized by preparing at least two or more electrical-potential-difference impression sections along the flexible direction of a flexible component, and changing as a change of an

electrical-potential-difference impression location being free.

[Claim 17] The actuator according to claim 1 or 13 carried out [installing a flexible component through the insulating movement transfer section, preparing the electrical-potential-difference impression section in the insulating movement transfer section of each flexible component, and the edge of the opposite side, impressing reverse potential to the electrical-potential-difference impression section of each flexible component, and making the insulating movement transfer section go up and down, and] as the description.

[Claim 18] The actuator according to claim 1 or 13 characterized by arranging a flexible component in the both sides of the rigid core material with which it was combined with by the link section and the rigid core material was combined by this link section, and growing into them.

[Claim 19] The actuator according to claim 1 characterized by preparing two or more flexible components, preparing the change section which switches impression of the electrical potential difference to these two or more flexible components, and generating the pattern of a flexible component of operation by voltage switching.

[Claim 20] The actuator according to claim 1 characterized by preparing the counterelectrode section in a core, installing at least three or more flexible components in the periphery section of the counterelectrode section, and switching impression of the electrical potential difference to three or more flexible components.

[Claim 21] The actuator according to claim 1 characterized by preparing the counterelectrode section which served as the flexible component to one side of a rigid core material where it was combined by the link section and the rigid core material was combined by this link section, and served as bias devices, such as a spring, to the side of another side, and changing.

[Claim 22] The actuator according to claim 21 characterized by preparing the tension guide for guiding the abbreviation center section of the flexible component in the link section, and growing into it.

[Claim 23] The actuator according to claim 1 which inserts two or more flexible components which have the electrical-potential-difference impression section in the counterelectrode section which carried out tubed, and is characterized by between the inner circumference of the counterelectrode section and the external surface of two or more flexible components which have the electrical-potential-difference impression section being an electrolyte in the interior of the tubed counterelectrode section.

[Claim 24] The actuator according to claim 1 which arranges the counterelectrode section in a core and is characterized by bending the thin-film-ized flexible component in the shape of a rib, and arranging and growing into the periphery section of the counterelectrode section.

[Claim 25] The actuator according to claim 24 characterized by being crooked in the shape of a rib and changing the counterelectrode section arranged to the core.

[Claim 26] The actuator according to claim 1 which arranges the counterelectrode section in a core, makes it spiral and is characterized by the thing which centered the thin-film-ized flexible component on the counterelectrode section, and which is arranged and grown into the perimeter of the counterelectrode section.

[Claim 27] The actuator according to claim 1 which makes spiral the flexible component and the counterelectrode section which were thin-film-ized, respectively, and is characterized by arranging and changing so that the core of both whorls may be common and the whorl of another side may meet the periphery of one whorl.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the actuator which consisted of flexible components expanded and contracted if an electrical potential difference is impressed within an electrolytic environment.

[0002]

[Description of the Prior Art] Consist of the power supply section for impressing an electrical potential difference to the flexible component which consists of pi conjugation mold polymeric materials, such as the poly aniline and polypyrrole, and this flexible component from the former and the electrical-potential-difference impression section, and the electrolyte for making it flow through a current outside from the flexible component section, the amount of ion doping of a flexible component is made to fluctuate by the oxidation reduction reaction by impressing forward or electronegative potential to the electrical-potential-difference impression section, and making a flexible component expand and contract is known. That is, if a flexible component will develop because the amount of ion doping of a flexible component increases if electropositive potential is impressed to the electrical-potential-difference impression section, and electronegative potential is impressed to the electrical-potential-difference impression section on the other hand, it will contract because the amount of ion doping of a flexible component decreases.

[0003] Although the force as an actuator could be discovered when it was going to use telescopic motion of the above flexible components as an actuator, and a flexible component contracted, when a flexible component was prolonged, the force as an actuator could not be discovered enough, but there was a problem that it could not use as an actuator which discovers the force to both telescopic motion.

[0004]

[Problem(s) to be Solved by the Invention] This invention is made in view of the above-mentioned point, and let it be a technical problem to offer the actuator which can discover the force as an actuator certainly with an easy configuration also at the time of elongation.

[0005]

[Means for Solving the Problem] The actuator applied to this invention in order to solve the above-mentioned technical problem The flexible component 1 which consists of pi conjugation mold polymeric materials, such as the poly aniline and polypyrrole, The power supply section 2 and the electrical-potential-difference impression section 3 for impressing an electrical potential difference to this flexible component 1; In the device which consists of the electrolyte 4 for making it flow through a current outside from the flexible component 1, the flexible component 1 will elongate if electropositive potential is impressed to the electrical-potential-difference impression section 3, and the flexible component 1 will contract if electronegative potential is impressed to the electrical-potential-difference impression section 3 The change of forward potential and negative potential is adjustable, and the power supply section 2 which establishes the bias devices 5, such as a spring which generates the force, and supplies potential in the elongation direction to the flexible component 1 to the electrical-potential-difference impression section 3 at the time of elongation is characterized by controlling the amount of telescopic motion of the flexible component 1 by the absolute value of an electrical-potential-difference value, and polar change. Although the amount of ion doping of the flexible component 1 increases and the flexible component 1 tends to develop by considering as such a configuration if forward potential is impressed to the electrical-potential-difference impression section 3, the force of the direction which elongates the flexible component 1 according to the bias devices 5, such as a spring, at this time occurs, and the actuator force of the elongation direction in case this uses as an actuator can be discovered. Moreover, in case negative potential is impressed to the electrical-potential-difference impression section 3 and the flexible component 1 contracts, the amount of ion doping of the flexible component 1 decreases, the force of the bias device 5 is resisted, the flexible component 1 contracts, and the actuator force of the contraction direction can be discovered.

[0006] Moreover, it is desirable to enclose an electrolyte 4 with the space which installs the counterelectrode section 7 in the electrical-potential-difference impression section 3, the flexible component 1, and its near, forms the covering sections 6, such as silicon, in the outermost periphery, and is formed between the counterelectrode section 7 and the flexible component 1. External leakage of an electrolyte 4 can be prevented and the actuator of a package mold can consist of considering as such a configuration.

[0007] Moreover, it is desirable to install the counterelectrode section 7 in the perimeter of the flexible component 1. Telescopic motion of the flexible component 1 will also be promoted by the electric field to the flexible component 1 becoming

homogeneity, an oxidation reduction reaction being promoted, and an oxidation reduction reaction being promoted in this way by considering as such a configuration.

[0008] Moreover, the counterelectrode section 7 is installed in the electrical-potential-difference impression section 3, the flexible component 1, and its near, and it is desirable that the counterelectrode section 7 is the network structure. By considering as such a configuration, the counterelectrode section 7 can follow in footsteps and carry out a form status change form to telescopic motion of the flexible component 1 with an easy configuration.

[0009] Moreover, it is desirable that the electrical-potential-difference impression section 3 is installed in the both ends of the flexible component 1, and performs electrical-potential-difference impression from a power supply section 2 from the both ends of the flexible component 1. By considering as such a configuration, charge grouting velocity becomes quick and the oxidation reduction reaction of the flexible component 1 will also be promoted.

[0010] Moreover, it is desirable that the contact of the electrical-potential-difference impression section 3 and the flexible component 1 is larger than the electrical conductivity of the flexible component 1. By considering as such a configuration, charge grouting velocity becomes quick and the oxidation reduction reaction of the flexible component 1 will also be promoted.

[0011] Moreover, it is desirable that install the counterelectrode section 7 in the electrical-potential-difference impression section 3, the flexible component 1, and its near, the bias device 5 is carrying out the shape of coiled spring, and this bias device 5 serves as the counterelectrode section 7. By considering as such a configuration, the bias device 5 and the counterelectrode section 7 can be made to serve a double purpose, and reduction of components mark can be performed.

[0012] Moreover, it is desirable that the covering section 6 which covers the outermost periphery consisted of elastic bodies, and serves as the bias device 5. By considering as such a configuration, the bias device 5 can be made to use also [object / 6 / covering], and reduction of components mark is made to it.

[0013] Moreover, it is desirable to install the counterelectrode section 7 in a core, to make the thin-film-ized flexible component 1 into the shape of a roll, and to arrange around the counterelectrode section 7. Thus, the surface area of the elongation component 1 can be made to be able to raise by making the elongation component 1 into the shape of a roll, a degree of shrinkage can be raised, and electric field can be impressed to homogeneity by installing the counterelectrode section 7 in a core at the counterelectrode section 7 of the shape of a surrounding roll.

[0014] Moreover, the thing of the flexible component 1 which carried out the shape of a roll for which the counterelectrode section 7 is arranged so that a periphery may be surrounded further is desirable. By considering as such a configuration, electric-field addition will be made in homogeneity to inside-and-outside both sides of the flexible component 1 which carried out the shape of a roll.

[0015] Moreover, it is desirable to arrange the flexible component 1 which carried out the shape of a roll, and the two or more layers counterelectrode section 7. By considering as such a configuration, the tensile strength at the time of contraction can improve.

[0016] Moreover, it is desirable that the actuator which arranged the flexible component 1 which carried out the shape of a roll, and the counterelectrode section 7 in the direction of a path is carrying out the shape of a tube. By considering as such a configuration, the tube which equipped radial with the function expanded and contracted can be offered.

[0017] Moreover, when a forward electrical potential difference is impressed to the flexible component 1 so that one side may contract in while, in case one pair of flexible component 1 is formed and one side develops for the flexible component 1 of this pair, it is desirable to impress a negative electrical potential difference to the flexible component 1 of another side. By considering as such a configuration, one actuator can realize a motion which is called elongation and contraction and which is different from each other to coincidence.

[0018] Moreover, it is desirable to install the flexible component 1 in the both sides of the elastic core material 8 of the configuration where the natural condition curved. By considering as such a configuration, the actuator which carries out curve movement which spreads in radial or narrows can be offered. Moreover, although negative potential will be impressed to the flexible component 1 of another side, it will contract and an actuator carries out curve actuation by this when forward potential is impressed to one flexible component 1 and it elongates by impressing an electrical potential difference between two flexible components 1. In this case, the bias device 5 for while to develop and for the flexible component 1 which another side contracts promote the crookedness elongation at the time of carrying out crookedness elongation of the flexible component 1 will be constituted. Therefore, the crookedness elongation force as an actuator can be discovered, without needing the special bias device 5 of another components.

[0019] Moreover, it is desirable to install the flexible component 1 in both the outsides of the elastic core material 8 of the shape of direct [of a center section]. When forward potential is impressed to one flexible component 1 and it elongates by impressing an electrical potential difference between two flexible components 1 by considering as such a configuration, negative potential will be impressed to the flexible component 1 of another side, it will contract, and, thereby, an actuator is crooked. In this case, the crookedness elongation force as an actuator can be discovered, without the flexible component 1 which another side contracts constituting the bias device 5 for while developing and promoting the crookedness elongation at the time of carrying out crookedness elongation of the flexible component 1, therefore needing the bias device 5 of another components.

[0020] Moreover, it is desirable to form at least two or more electrical-potential-difference impression sections 3 along the flexible direction of the flexible component 1, and to enable the change of an electrical-potential-difference impression location. The curvature at the time of crookedness is easily controllable by switching an electrical-potential-difference impression location considering as such a configuration.

[0021] Moreover, it is desirable to install the flexible component 1 through the insulating movement transfer section 9, to form

the electrical-potential-difference impression section 3 in the insulating movement transfer section 9 of each flexible component 1 and the edge of the opposite side, to impress reverse potential to the electrical-potential-difference impression section 3 of each flexible component 1, and to make the insulating movement transfer section 9 go up and down. By impressing electropositive potential to one flexible component 1, and impressing electronegative potential to the flexible component 1 of another side by considering as such a configuration, one flexible component 1 develops, the flexible component 1 of another side contracts, and, thereby, the insulating movement transfer section 9 moves up and down. In this case, the straight-line elongation force as an actuator can be discovered, without the flexible component 1 which another side contracts constituting the bias device 5 for while developing and promoting the elongation at the time of the flexible component 1 developing, therefore needing the bias device 5 of another components.

[0022] Moreover, it is desirable to arrange the flexible component 1 in the both sides of the rigid core material 10 with which it was combined with by the link section 11 and the rigid core material 10 was combined by this link section 11. When forward potential is impressed to one flexible component 1 and it elongates by considering as such a configuration, negative potential will be impressed to the flexible component 1 of another side, and it will contract, and thereby, an actuator is crooked in link section 11 part, and joint-crookedness is performed. In this case, the crookedness elongation force as an actuator can be discovered, without the flexible component 1 which another side contracts constituting the bias device 5 for while developing and promoting the crookedness elongation at the time of carrying out crookedness elongation of the flexible component 1, therefore needing the bias device 5 of another components.

[0023] Moreover, it is desirable to form two or more flexible components 1, to form the change section 12 which switches impression of the electrical potential difference to these two or more flexible components 1, and to generate the pattern of the flexible component 1 of operation by voltage switching. By considering as such a configuration, by changing various electrical-potential-difference impression change patterns to two or more flexible components 1, will make coincidence elongate all the flexible components 1, it will be made to contract, or combination of elongation and contraction will be changed, and an actuator with a high degree of freedom can be offered.

[0024] Moreover, it is desirable to form the counterelectrode section 7 in a core, to install at least three or more flexible components 1 in the periphery section of the counterelectrode section 7, and to switch impression of the electrical potential difference to three or more flexible components 1. By considering as such a configuration, the actuator which can perform three-dimension crookedness actuation can be offered. In this case, the crookedness elongation force as an actuator can be discovered, without the flexible component 1 to contract constituting the bias device 5 for promoting the crookedness elongation at the time of carrying out crookedness elongation of the flexible component 1 to elongate, therefore needing the bias device 5 of another components.

[0025] Moreover, it is desirable to form the counterelectrode section 7 which served as the flexible component 1 to one side of the rigid core material 10 where it was combined by the link section 11 and the rigid core material 10 was combined by this link section 11, and served as the bias devices 5, such as a spring, to the side of another side. By considering as such a configuration, an actuator is crooked in link section 11 part, and joint-crookedness is performed. Moreover, components mark are reducible by having made the bias device 5 and the counterelectrode section 7 as which it served serve a double purpose.

[0026] Moreover, it is desirable to form the tension guide 13 for guiding the abbreviation center section of the flexible component 1 to the link section 11. Larger crookedness can be performed in the small amount of contraction by being guided with the tension guide 13 by considering as such a configuration, in case the flexible component 1 contracts.

[0027] Moreover, two or more flexible components 1 which have the electrical-potential-difference impression section 3 are inserted in the counterelectrode section 7 which carried-out tubed; and ** between [whose] the inner circumference of the counterelectrode section 7 and the external surface of two or more flexible components 1 which have the electrical-potential-difference impression section 3 is an electrolyte 4 is desirable in the interior of the tubed counterelectrode section 7. By considering as such a configuration, each flexible component 1 can perform flexible actuation, and can consider as the actuator of large direct-acting of the generating force as a whole.

[0028] Moreover, the counterelectrode section 7 is arranged in a core and it is desirable to bend the thin-film-ized flexible component 1 in the shape of a rib, and to arrange in the periphery section of the counterelectrode section 7. By considering as such a configuration, also with the actuator of the same size, surface area of the flexible component 1 can be enlarged and the generating force at the time of telescopic motion can be enlarged. Moreover, electric field can be added to the surrounding flexible component 1 by installing the counterelectrode section 7 in a core at homogeneity.

[0029] Moreover, it is desirable that the counterelectrode section 7 arranged to the core is crooked in the shape of a rib. The oxidation reduction reaction of a polymer is promoted by being able to enlarge surface area of the flexible component 1 also with the actuator of the same size, and being able to enlarge the generating force at the time of telescopic motion, and bending the counterelectrode section 7 in the shape of a rib by considering as such a configuration, and the flexible rate at the time of telescopic motion becomes quick.

[0030] Moreover, the counterelectrode section 7 is arranged in a core and the thing which centered the thin-film-ized flexible component 1 on the counterelectrode section 7 and which it is made spiral and arranged around a counterelectrode is desirable. By considering as such a configuration, also with the actuator of the same size, surface area of the flexible component 1 can be enlarged and the generating force at the time of telescopic motion can be enlarged.

[0031] Moreover, the flexible component 1 and the counterelectrode section 7 which were thin-film-ized are made spiral, respectively, and the core of both whorls is common, and it is desirable to arrange so that the whorl of another side may meet the periphery of one whorl. By considering as such a configuration, surface area of the flexible component 1 can be enlarged also

with the actuator of the same size, the generating force at the time of telescopic motion can be enlarged, and the core of both whorls is common, and the oxidation reduction reaction of a polymer is promoted by arranging so that the whorl of another side may meet the periphery of one whorl, and the flexible rate at the time of telescopic motion becomes quick.

[0032]

[Embodiment of the Invention] Hereafter, this invention is explained based on the operation gestalt shown in an accompanying drawing.

[0033] The principle Fig. of the actuator of this invention is shown in drawing 1. The actuator of this invention establishes and constitutes the bias devices 5, such as a spring which generates the force, in the elongation direction at the time of the flexible component 1 which consisted of pi conjugation mold polymeric materials, such as the poly aniline and polypyrrole, the power supply section 2 for impressing an electrical potential difference to this flexible component 1 and the electrical-potential-difference impression section 3, the electrolyte 4 for making it flow through a current outside from the flexible component 1, and elongation of the flexible component 1. Here, H₂SO₄ which produces what has a certain amount of as an electrolyte 4 used for this invention] molecular weight as an anion, for example, SO₄²⁻, Na₂SO₄, HCl which produces Cl⁻, HPF₆, HBF₄ which produce F⁻, etc. can be used.

[0034] And if the amount of ion doping of a flexible component will increase by the oxidation reduction reaction, the flexible component 1 will develop, if the electrical potential difference of electropositive potential is impressed to the electrical-potential-difference impression section 3, and the electrical potential difference of electronegative potential is conversely impressed to the electrical-potential-difference impression section 3, the amount of ion doping of a flexible component will decrease, and the flexible component 1 will contract.

[0035] A deer is carried out, the force of the elongation direction will act according to the bias devices 5, such as a spring, and the actuator of this invention can discover the actuator force at the time of elongation, in case the electrical potential difference of electropositive potential is impressed to the electrical-potential-difference impression section 3 and the flexible component 1 develops like drawing 1 (b), since the bias devices 5, such as a spring which generates the force in the elongation direction at the time of elongation of the flexible component 1, have been established. Here, when the bias device 5 is a spring as an operation gestalt, the force in which a spring tends to return to natural length at the time of elongation of the flexible component 1 occurs in the elongation direction. On the other hand, like drawing 1 (c), in case the electrical potential difference of electronegative potential is impressed to the electrical-potential-difference impression section 3 and the flexible component 1 contracts, the flexible component 1 contracts by the pull strength which resists the force of the elongation direction by the bias devices 5, such as a spring, and the actuator force at the time of contraction is discovered.

[0036] The symbol description of a bias device is shown in drawing 2. Namely, drawing 2 (a) shows the unloaded condition which is not impressing the electrical potential difference to the electrical-potential-difference impression section 3, and the bias devices 5, such as a spring, are acting the force in the direction which expands the flexible component 1. The condition that drawing 2 (b) impressed the electrical potential difference of electropositive potential to the electrical-potential-difference impression section 3, and the flexible component 1 developed is shown, and the bias devices 5, such as a spring, are acting the force in the direction which expands the flexible component 1. The condition that drawing 2 (c) impressed the electrical potential difference of electronegative potential to the electrical-potential-difference impression section 3, and the flexible component 1 contracted was shown, the bias devices 5, such as a spring, were resisted, and the flexible component 1 has discovered pull strength in the contraction direction. While the force to the elongation direction of the bias device 5 is added at the time of elongation of the flexible component 1 and discovering the actuator force in the elongation direction by this, pull strength is discovered at the time of contraction, and the time of elongation and contraction can discover the actuator force.

[0037] Drawing 3 (a) can change the absolute value of the amount of telescopic motion with the absolute value of the electrical potential difference impressed to the flexible component 1 so that clearly [it may be the graph which shows the relation between an electrical potential difference and the amount of telescopic motion and] from this graph. Moreover, drawing 3 (b) is an explanatory view for explaining reversal of the flexible direction by the polarity. The change of elongation and contraction is what is realized by changing the polarity of the electrical potential difference impressed to the flexible component 1. The flexible component 1 develops by impressing the electrical potential difference of electropositive potential to the electrical-potential-difference impression section 3, the flexible component 1 contracts by impressing the electrical potential difference of electronegative potential to the electrical-potential-difference impression section 3, and the actuator which can perform control of elongation and contraction in easy control of changing the polarity of an electrical potential difference can be offered.

[0038] One operation gestalt of the actuator of this invention is shown in drawing 4. The flexible component 1 which formed the electrical-potential-difference impression section 3 in the end section is arranged in the tubed covering section 6 formed with the silicon which has deformans. Blockade vertical opening of the tubed covering section 6 by the lock out section 15, and the spring which constitutes the bias device 5 in which the force is given is further arranged in the direction which the outside of the flexible component 1 is made to elongate at the time of elongation of the flexible component 1. Moreover, the counterelectrode section 7 is arranged up and down over the inside of the covering section 6, and the electrolyte 4 is enclosed with the space (that is, inside of the covering section 2) formed between the counterelectrode section 7 and the flexible component 1. And the electrical-potential-difference impression section 3 and the counterelectrode section 7 are connected to the power supply section 2.

[0039] If a deer is carried out, the electrical potential difference of forward potential is impressed to the electrical-potential-difference impression section 3 and electronegative potential is impressed to the counterelectrode section 7,

the flexible component 1 will develop (the force of the elongation direction acts according to the bias device 5 at this time, and the actuator force in the elongation direction is discovered). Moreover, if the electrical potential difference of negative potential is impressed to the electrical-potential-difference impression section 3 and electropositive potential is impressed to the counterelectrode section 7, the pull strength which the flexible component 1 contracts and resists the force of the elongation direction by the bias device 5 will arise, and the actuator force in the contraction direction will be discovered. In this operation gestalt, an electrolyte 4 can be prevented from revealing outside with an easy configuration, and the actuator of a package mold can be constituted.

[0040] Other operation gestalten of the actuator of this invention are shown in drawing 5. Although the fundamental configuration of this operation gestalt is the same as that of the operation gestalt shown in above-mentioned drawing 4, the point which has arranged the counterelectrode section 7 around the flexible component 1 differs from what is shown in drawing 4. That is, in this operation gestalt, the covering section 6 which carried out tubed is carrying out the shape of a cylindrical shape, and the counterelectrode section 7 which carried out the shape of a cylinder along with the inner skin of the covering section 6 which carried out the shape of this cylindrical shape is arranged. In this operation gestalt, although explanation is omitted since the actuation as an actuator in this operation gestalt is the same as that of the operation gestalt shown in above-mentioned drawing 4, since the counterelectrode section 7 is installed in the perimeter of the flexible component 1, it is that the electric field to the flexible component 1 become homogeneity, an oxidation reduction reaction is promoted, and an oxidation reduction reaction is promoted in this way, and telescopic motion of the flexible component 1 will also be promoted.

[0041] The operation gestalt of further others of the actuator of this invention is shown in drawing 6. In this operation gestalt, as the counterelectrode section 7 shows drawing 6 (c), it is only that the points used as the elastic network structure differ, and other configurations have the same composition as the operation gestalt shown in drawing 4 or drawing 5, and the explanation which overlaps since the same is said of the actuation as an actuator is omitted. When the actuator does not expand and contract by carrying out a deer and making the counterelectrode section 7 into the network structure in this operation gestalt, it is in the condition of drawing 6 (c), but when an actuator contracts, the counterelectrode section 7 of the network structure follows in footsteps and contracts like drawing 6 (d), and when an actuator develops, the counterelectrode section 7 of the network structure follows in footsteps and develops like drawing 6 (e). Thus, the counterelectrode section 7 can be installed in the electrical-potential-difference impression section 3, the flexible component 1, and its near, and a form status change form can be followed in footsteps and carried out to telescopic motion of the flexible component 1 in the counterelectrode section 7 of an easy configuration by the counterelectrode section 7 considering as the network structure. In addition, although drawing 6 shows the example to which the counterelectrode 7 of the network structure is carrying out the shape of a cylinder, the counterelectrode 7 of the network structure may carry out the shape of a piece.

[0042] The operation gestalt of further others of the actuator of this invention is shown in drawing 7. In this operation gestalt, the electrical-potential-difference impression section 3 is installed in the both ends of the flexible component 1, the description is to perform electrical-potential-difference impression from a power supply section 2 from the both ends of the flexible component 1, and since other configurations have the same composition as one of the operation gestalten shown in drawing 4 thru/or drawing 6, explanation of a configuration of overlapping is omitted. Moreover, the explanation which overlaps since actuation same as the actuation as an actuator is performed is omitted. Since a deer is carried out, the electrical-potential-difference impression section 3 is installed in the both ends of the flexible component 1 in this operation gestalt and electrical-potential-difference impression from a power supply section 2 is performed from the both ends of the flexible component 1, charge grouting velocity becomes quick, the oxidation reduction reaction of the flexible component 1 is also promoted, and the rate of telescopic motion of the flexible component 1 becomes quick.

[0043] By the way, also in which operation gestalt shown in above-mentioned drawing 4 thru/or above-mentioned drawing 7, it is good for metals, such as large copper and silver, to constitute the contact 16 of the electrical-potential-difference impression section 3 and the flexible component 1 from the electrical conductivity of the flexible component 1 (refer to drawing 8). By considering as such a configuration, charge grouting velocity becomes quick, the oxidation reduction reaction of the flexible component 1 is also promoted, and the rate of telescopic motion of the flexible component 1 becomes quick. Since it is the same as that of each above-mentioned operation gestalt about a configuration and actuation, the overlapping explanation is omitted.

[0044] The operation gestalt of further others of this invention is shown in drawing 9. In this operation gestalt, other configurations except the counterelectrode section 7 and the bias device 5 are the same as the operation gestalt shown in either drawing 4 thru/or drawing 8. Therefore, since explanation of a configuration of that it is common in the operation gestalt shown in either drawing 4 thru/or drawing 8 and explanation of the actuation as an actuator overlap, they are omitted, and only a different configuration is explained. That is, in this operation gestalt, it is constituting the bias device 5 with metal coiled spring, and the description of this operation gestalt is in the point of having made the counterelectrode section 7 using also [device / 5 / bias]. Thereby, the bias device 5 and the counterelectrode section 7 can be made to serve a double purpose, and reduction of components mark can be performed.

[0045] The operation gestalt of further others of this invention is shown in drawing 10. In this operation gestalt, other configurations except the covering section 6 and the bias device 5 which cover the outermost periphery are the same as the operation gestalt shown in either drawing 4 thru/or drawing 8. Therefore, since explanation of a configuration of that it is common in the operation gestalt shown in either drawing 4 thru/or drawing 8 and explanation of the actuation as an actuator overlap, they are omitted, and only a different configuration is explained. That is, in this operation gestalt, the description is in the point that the covering section 6 which covers the outermost periphery consisted of elastic bodies like rubber, and served as the bias device 5. Thereby, the covering section 6 and the bias device 5 can be made to serve a double purpose, and reduction of

components mark can be performed. Here, the function as a bias device 5 in which the force is generated in the elongation direction can be given to the covering section 6 at the time of elongation of a flexible component by giving and installing the initial resistance which it is going to prolong in the elongation direction in elastic bodies, such as rubber which constitutes the bias device 5.

[0046] Next, the operation gestalt of further others of this invention is explained based on drawing 11. Although it is the example which has arranged the flexible component 1 to the core in the operation gestalt shown in drawing 5 thru/or drawing 8, and has arranged the counterelectrode 7 around the flexible component 1. The operation gestalt and configuration which the point which made the flexible component 1 which installed and thin-film-ized the counterelectrode section 7 to the core in the operation gestalt shown in drawing 11 the shape of a roll, and has been arranged around the counterelectrode section 7 shows to drawing 5 thru/or drawing 8 differ from each other. Other configurations are the same as that of the operation gestalt shown in either drawing 5 thru/or drawing 8, and since the actuation as an actuator is also common, explanation of a common configuration and actuation is omitted. By making the thin-film-ized flexible component 1 which carried out the deer into the shape of a roll, and arranging around the counterelectrode section 7, also with the actuator of the same size, the cross section of the flexible component 1 can be enlarged and the generating force at the time of telescopic motion can be enlarged. Moreover, electric field can be impressed to the surrounding flexible component 1 by installing the counterelectrode section 7 in a core at homogeneity.

[0047] Next, the operation gestalt of further others of this invention is explained based on drawing 12. In this operation gestalt, in the operation gestalt shown in above-mentioned drawing 11, additional installation of the counterelectrode section 7 is further carried out so that the periphery of the flexible component 1 installed in the shape of a roll may be surrounded, and since it is the same as that of the operation gestalt shown in drawing 11, other configurations and actuation are omitted. In this operation gestalt, the electrical-potential-difference impression to the flexible component 1 serves as front flesh-side homogeneity, the oxidation reduction reaction of the flexible component 1 will be promoted, and telescopic motion of the flexible component 1 will be promoted as a result.

[0048] Next, the operation gestalt of further others of this invention is explained based on drawing 13. In this operation gestalt, in the operation gestalt shown in above-mentioned drawing 12, two or more layers the flexible component 1 and the counterelectrode section 7 which were installed in the shape of a roll are arranged, and since it is the same as that of the operation gestalt shown in drawing 12, other configurations and actuation are omitted. In this operation gestalt, since flexible promotion of the flexible component 1 of all layers is carried out and the cross section of the flexible component 1 increases, the generating force of the flexible direction will rise.

[0049] Next, the operation gestalt of further others of this invention is explained based on drawing 14. In this operation gestalt, the actuator which arranged the flexible component 1 which carried out the shape of a roll, and the counterelectrode section 7 in the direction of a path is carrying out the shape of a tube. That is, the covering section 6 which has the elasticity to which tube-like the inner skin section and the peripheral face section of an actuator carried out the shape of a roll in drawing 14 constitutes. The counterelectrode section 7 which considered the shape of a roll as the flexible component 1 which carried out the shape of a roll which formed the electrical-potential-difference impression section 3 between the covering sections 6 of both the inside-and-outside periphery is arranged, and between the vertical edges between the covering sections 6 of both the inside-and-outside periphery is blockaded, and the electrolyte 4 is enclosed between the covering sections 6 of an inside-and-outside periphery. And in this operation gestalt, if the electrical potential difference of forward potential is impressed to the electrical-potential-difference impression section 3 and electronegative potential is impressed to the counterelectrode section 7, the flexible roll-like component 1 will develop to radial; and conversely; if the electrical potential difference of negative potential is impressed to the electrical-potential-difference impression section 3 and electropositive potential is impressed to the counterelectrode section 7, the flexible roll-like component 1 will contract to radial. Here, although illustration is omitted in this operation gestalt, bias devices, such as a spring which generates the force, are established in the elongation direction at the time of the elongation to radial [of the flexible component 1], and the actuator force can be discovered to radial at the time of elongation. Thus, since it can do, it is the thing for which it makes radial expand and contract a tube-like actuator and which can be used as the pressure massage of a finger, an arm, etc., a sphygmomanometer, etc., for example.

[0050] Next, the principle Fig. of other operation gestalten of this invention is shown in drawing 15. That is, one pair of flexible component 1 which formed the electrical-potential-difference impression section 3 in this operation gestalt is formed, an electrolyte 4 is enclosed between both the flexible components 1, and when the electrical potential difference of forward potential is impressed to the electrical-potential-difference impression section 3 of one flexible component 1, both the electrical-potential-differences impression section 3 is connected to a power supply section 2, respectively so that negative potential may be impressed to the electrical-potential-difference impression section 3 of another side. And when the electrical potential difference of forward potential is impressed to the electrical-potential-difference impression section 3 of above-mentioned one flexible component 1 and the electrical potential difference of negative potential is impressed to the electrical-potential-difference impression section 3 of the flexible component 1 of another side, one flexible component 1 will develop, the flexible component 1 of another side will contract, and one actuator can realize a motion which is called elongation and contraction and which is different from each other to coincidence.

[0051] One operation gestalt adapting this principle is shown in drawing 16. The flexible component 1 which curved at the arc on both sides of the elastic core material 8 which carried out the configuration where the natural condition curved to the arc, in this operation gestalt is arranged, the electrical-potential-difference impression section 3 is formed in this flexible component 1, the periphery section of an actuator is covered with the covering section 6, the both ends of the actuator which carried out the arc

are further blockaded in the lock out section 15, and an electrolyte 4 is enclosed with the interior. Carry out a deer and the electrical potential difference of forward potential is impressed to the electrical-potential-difference impression section 3 of one flexible component 1. When the electrical potential difference of negative potential is impressed to the electrical-potential-difference impression section 3 of the flexible component 1 of another side, the flexible component 1 which carried out one arc develops. The actuator which the flexible component 1 which carried out the arc of another side will contract, carried out actuation contrary to the above when potential of the electrical potential difference to impress was made reverse, and carried out the arc by this carries out curve actuation which spreads in radial or is contracted (it operates in the direction of an arrow head of drawing 16). As mentioned above, although negative potential will be impressed to the flexible component 1 of another side, it will contract and an actuator carries out curve actuation by this when forward potential is impressed to one flexible component 1 and it elongates by impressing an electrical potential difference between two flexible components 1. In this case, the bias device 5 for while to develop and for the flexible component 1 which another side contracts promote the crookedness elongation at the time of carrying out crookedness elongation of the flexible component 1 will be constituted. Therefore, the crookedness elongation force as an actuator can be discovered, without needing the special bias device 5 of another components.

[0052] Although shown in drawing 17 at drawing 15, other operation gestalten adapting a principle are shown. That is, the flexible component 1 which formed the electrical-potential-difference impression section 3 in the upper limit section is installed in both the outsides of the elastic core material 8 of the shape of direct [of a center section], a periphery is covered with the covering section 6, upper limit section opening is blockaded in the lock out section 15, an electrolyte 4 is enclosed with the interior, and an actuator is constituted. Carry out a deer and the electrical potential difference of forward potential is impressed to the electrical-potential-difference impression section 3 of one flexible component 1. When the electrical potential difference of negative potential is impressed to the electrical-potential-difference impression section 3 of the flexible component 1 of another side, one flexible component 1 develops. It is crooked so that the flexible component 1 which carried out the arc of another side will contract, actuation contrary to the above may be carried out when potential of the electrical potential difference to impress is made reverse, and an actuator may carry out neck swing movement to right and left like the arrow head of drawing 17 by this. As mentioned above, the flexible component 1 which formed the electrical-potential-difference impression section 3 in the upper limit section is installed in both the outsides of the elastic core material 8 of the shape of direct [of a center section], when forward potential is impressed to one flexible component 1 and it elongates by impressing an electrical potential difference between two flexible components 1, negative potential will be impressed to the flexible component 1 of another side, it will contract, and, thereby, an actuator is crooked. In this case, the crookedness elongation force as an actuator can be discovered, without the flexible component 1 which another side contracts constituting the bias device 5 for while developing and promoting the crookedness elongation at the time of carrying out crookedness elongation of the flexible component 1, therefore needing the bias device 5 of another components.

[0053] Although shown in drawing 18 at drawing 15, the operation gestalt adapting a principle of further others is shown. That is, this operation gestalt shown in drawing 18 forms at least two or more electrical-potential-difference impression sections 3 along the flexible direction of the flexible component 1 in the operation gestalt shown in drawing 17. Fundamental actuation of the actuator of this operation gestalt is crooked so that it may be the same as what is shown in drawing 17 and an actuator may carry out neck swing movement to right and left. And an electrical-potential-difference impression location is switched by choosing ON of these switches connected to the electrical-potential-difference impression section 3 which has formed the switch 20 in the parallel circuit section which connects each electrical-potential-difference impression section 3 and a power supply section 2, respectively, and were prepared along the flexible-direction; and an off change. Since the amount of telescopic motion of the flexible component 1 changes with electrical-potential-difference impression locations, the rate of crookedness of an actuator can be controlled as a result.

[0054] Other operation gestalten of this invention are shown in drawing 19. The flexible component 1 is installed through the insulating movement transfer section 9, the electrical-potential-difference impression section 3 is formed in the insulating movement transfer section 9 of each flexible component 1, and the edge of the opposite side, a periphery is covered with the covering section 6, vertical both-ends opening is blockaded in the lock out section 15, an electrolyte 4 is enclosed with the interior, and the actuator consists of these operation gestalten. A deer is carried out, in this operation gestalt, it is impressing electropositive potential to one flexible component 1, and impressing electronegative potential to the flexible component 1 of another side, one flexible component 1 develops, the flexible component 1 of another side contracts, and, thereby, the insulating movement transfer section 9 moves up and down. In this case, the straight-line elongation force as an actuator can be discovered, without the flexible component 1 which another side contracts constituting the bias device 5 for while developing and promoting the elongation at the time of the flexible component 1 developing, therefore needing the bias device 5 of another components.

[0055] Other operation gestalten of this invention are shown in drawing 20. In this operation gestalt, the up-and-down rigid core material 10 arranges the flexible component 1 which formed the electrical-potential-difference impression section 3 in the both sides of the rigid core material 10 which has joined together by the link section 11 and was combined by this link section 11, respectively, covers a periphery with the covering section 6, blockades vertical both-ends opening in the lock out section 15, encloses an electrolyte 4 with the interior, and constitutes the actuator. A deer is carried out, when forward potential is impressed to one flexible component 1 and it elongates in this operation gestalt, negative potential will be impressed to the flexible component 1 of another side, and it will contract, and thereby, an actuator is crooked in link section 11 part, and joint-crookedness is performed. In this case, the crookedness elongation force as an actuator can be discovered, without the flexible component 1 which another side contracts constituting the bias device 5 for while developing and promoting the

crookedness elongation at the time of carrying out crookedness elongation of the flexible component 1, therefore needing the bias device 5 of another components. Thus, the actuator which carries out an articular movement in this operation gestalt can be offered.

[0056] Next, the principle Fig. of the operation gestalt of further others of this invention is shown in drawing 21. That is, in this operation gestalt, two or more flexible components 1 are formed, the change section 12 which switches impression of the electrical potential difference to these two or more flexible components 1 is formed, and voltage switching generates the pattern of the flexible component 1 of operation. That is, a switch 20 is formed in the circuit section which connects each flexible component 1 and a power supply section 2, respectively, and the change section 12 which consists of these switches is constituted. In the change section 12, by and the thing for which impression of the electrical potential difference to the two or more above-mentioned flexible components 1 is switched Various electrical-potential-difference impression change patterns to two or more flexible components 1 are changeable., make it contract or [making coincidence elongate all the flexible components 1] or -- expanding only the flexible component 1 of arbitration or making it contract **** -- as -- the combination of elongation and contraction is changed and a small actuator with a high degree of freedom can be offered.

[0057] Next, the operation gestalt of further others of this invention is shown in drawing 22. In this operation gestalt, the counterelectrode section 7 is formed in a core and at least three or more flexible components 1 are installed in the periphery section of the counterelectrode section 7. **** arranges two or more flexible components 1 in drawing 22 annularly, and arranges an insulator 25 in it between the adjoining flexible components 1. A periphery is covered with the covering section 6 also in this operation gestalt, and the electrolyte 4 is enclosed with the interior. Moreover, although illustration is omitted, vertical both-ends opening is blockaded in the lock out section, and the electrical-potential-difference impression section 3 is formed in the flexible component 1. And the switch 20 is formed in the parallel circuit section which connects each flexible component 1 and a power supply section 2, respectively, and the change section 12 is constituted. A deer is carried out, by making the whole into this potential by changing the electrical-potential-difference impression pattern to three or more flexible components 1, it can contract to the Z direction in drawing 22, or the actuator which can perform three-dimension-crookedness actuation of X, Y, and theta (twist angle [as opposed to X and Y in theta]) can be offered by making a part into forward potential and making other parts into negative potential among three or more flexible components 1. In this case, the crookedness elongation force as an actuator can be discovered, without the flexible component 1 to contract constituting the bias device 5 for promoting the crookedness elongation at the time of carrying out crookedness elongation of the flexible component 1 to elongate, therefore needing the bias device 5 of another components.

[0058] Next, based on drawing 23, it explains per operation gestalt of further others of this invention. In this operation gestalt, the counterelectrode section 7 which served the flexible component 1 which formed the electrical-potential-difference impression section 3 in one side of the rigid core material 10 where it was combined by the link section 11 and the rigid core material 10 was combined by this link section 11 as the bias devices 5, such as a spring, to the side of another side is formed. The bias device 5 in which the counterelectrode section 7 is made to serve a double purpose by the metal extension spring consists of operation gestalten of drawing 23. Moreover, a periphery is covered with the covering section 6, vertical both-ends opening is blockaded in the lock out section 15, an electrolyte 4 is enclosed with the interior, and the actuator is constituted. Although the flexible component 1 develops and it is crooked in the counterelectrode section 7 side focusing on the link section 11 when the electrical potential difference of forward potential is impressed to the electrical-potential-difference impression section 3 and the electrical potential difference of negative potential is impressed to the counterelectrode section 7 in this thing Since the extension spring constitutes the bias device 5 in which the counterelectrode section 7 is made to serve a double purpose, at this time, the force crooked in the counterelectrode section 7-side-focusing on the link section 11 in the rigid-body core material 10 will act, and the force of the elongation direction of the flexible component 1 will be given. On the other hand, when the electrical potential difference of negative potential is impressed to the electrical-potential-difference impression section 3 and the electrical potential difference of forward potential is impressed to the counterelectrode section 7, the spring force which constitutes the above-mentioned bias device 5 is resisted, the flexible component 1 contracts, and the rigid-body core material 10 is crooked in the counterelectrode section 7 and the opposite side focusing on the link section 11. Thus, an actuator is crooked by the articular movement in the counterelectrode section 7 and flexible component 1 side focusing on the ring section 11. Moreover, components mark are reducible with this operation gestalt by having made the bias device 5 and the counterelectrode section 7 as which it served serve a double purpose.

[0059] Here, the tension guide 13 for guiding the abbreviation center section of the flexible component 1 to the thing of the operation gestalt of drawing 23 further, as shown in drawing 24 may be formed in the link section 11. Thus, by forming the tension guide 13 for guiding the abbreviation center section of the flexible component 1 to the link section 11, in case the flexible component 1 contracts, it will be guided with the tension guide 13, and larger crookedness can be performed in the small amount of contraction.

[0060] Next, based on drawing 25, it explains per other operation gestalten of this invention. In this operation gestalt, two or more flexible components 1 which have the electrical-potential-difference impression section 3 are inserted in the counterelectrode section 7 which carried out tubed, and it is filled up with the electrolyte 4 in the interior of the tubed counterelectrode section 7 between the inner circumference of the counterelectrode section 7, and the external surface of two or more flexible components 1 which have the electrical-potential-difference impression section 3. Here, tubed is carried out, it has the electrical-potential-difference impression section 3 in the end section, and the flexible component 1 is inserted in cylindrical or the counterelectrode section 7 which made this the bundle and carried out tubed. In addition, although drawing 25 is a schematic diagram and illustration of bias devices, such as a spring, is omitted, a bias device may be established to the flexible

component 1 which may establish a bias device as well as each above-mentioned operation gestalt, and could establish bias devices, such as a spring, for every flexible component in this case, or became a bundle.

[0061] And although the flexible component 1 contracts because the flexible component 1 develops by impressing electropositive potential to the electrical-potential-difference impression section 3, and impressing the electrical potential difference of electronegative potential to the counterelectrode section 7 in this operation gestalt, and impress electronegative potential to the electrical-potential-difference impression section 3 and it impresses the electrical potential difference of electropositive potential to the counterelectrode section 7 Each flexible component 1 performs flexible actuation, the cross-sectional area and surface area of a flexible component increase, and it can consider as the actuator of direct-acting of the big generating force.

[0062] Next, based on drawing 26, it explains per other operation gestalten of this invention. In this operation gestalt, it has composition which bent the flexible component 1 which arranges and thin-film-ized the counterelectrode section 7 to the core in the shape of a rib, and has been arranged in the periphery section of the counterelectrode section 7. Although the flexible component 1 contracts because the flexible component 1 develops by impressing electropositive potential to the electrical-potential-difference impression section 3, and impressing the electrical potential difference of electronegative potential to the counterelectrode section 7 also in this operation gestalt, and impress electronegative potential to the electrical-potential-difference impression section 3 and it impresses the electrical potential difference of electropositive potential to the counterelectrode section 7 The counterelectrode section 7 is arranged in a core, by bending the thin-film-ized flexible component 1 in the shape of a rib, and arranging in the periphery section of the counterelectrode section 7, also with the actuator of the same size, surface area of the flexible component 1 can be enlarged and the generating force at the time of telescopic motion can be enlarged. Moreover, electric field can be added to the surrounding flexible component 1 by installing a counterelectrode 7 in a core at homogeneity.

[0063] Next, based on drawing 27, it explains per operation gestalt of further others of this invention. In this operation gestalt, in the operation gestalt of above-mentioned drawing 26, further, the counterelectrode section 7 arranged to the core is crooked in the shape of a rib, as shown in drawing 27. Also in this operation gestalt, the flexible component 1 contracts because the flexible component 1 develops by impressing electropositive potential to the electrical-potential-difference impression section 3, and impressing the electrical potential difference of electronegative potential to the counterelectrode section 7, and impress electronegative potential to the electrical-potential-difference impression section 3 and it impresses the electrical potential difference of electropositive potential to the counterelectrode section 7. And also in this operation gestalt, in addition to the ability to enlarge surface area of the flexible component 1 and enlarge the generating force at the time of telescopic motion also with the actuator of the same size, like the operation gestalt of drawing 26, the oxidation reduction reaction of a polymer (pi conjugation mold polymeric materials which constitute the flexible component 1, such as the poly aniline and polypyrrole) be promote by bend the counterelectrode section 7 in the shape of a rib further again, and the flexible rate at the time of telescopic motion become quick.

[0064] Next, based on drawing 28, it explains per operation gestalt of further others of this invention. In this operation gestalt, it has composition of the flexible component 1 which arranges and thin-film-ized the counterelectrode section 7 to the core which made spiral and has been arranged around a counterelectrode centering on the counterelectrode section 7. Although the flexible component 1 contracts because the flexible component 1 develops also in this operation gestalt by impressing electropositive potential to the electrical-potential-difference impression section 3, and impressing the electrical potential difference of electronegative potential to the counterelectrode section 7, and impress electronegative potential to the electrical-potential-difference impression section 3 and it impresses the electrical potential difference of electropositive potential to the counterelectrode section 7 By the thing which centered the thin-film-ized flexible component 1 on the counterelectrode section 7 and which it is made spiral and arranged around a counterelectrode, also with the actuator of the same size, surface area of the flexible component 1 can be enlarged and the generating force at the time of telescopic motion can be enlarged.

[0065] Next, based on drawing 29, it explains per operation gestalt of further others of this invention. In this operation gestalt, the flexible component 1 and the counterelectrode section 7 which were thin-film-ized are made spiral, respectively, and the core of both whorls is common and it has composition arranged so that the whorl of another side may meet the periphery of one whorl. Although the flexible component 1 contracts because the flexible component 1 develops also in this operation gestalt by impressing electropositive potential to the electrical-potential-difference impression section 3, and impressing the electrical potential difference of electronegative potential to the counterelectrode section 7, and impress electronegative potential to the electrical-potential-difference impression section 3 and it impresses the electrical potential difference of electropositive potential to the counterelectrode section 7 By thin-film-izing the flexible component 1, also with the actuator of the same size, surface area of the flexible component 1 can be enlarged and the generating force at the time of telescopic motion can be enlarged. Moreover, the core of both whorls is common, and by arranging so that the whorl of another side may meet the periphery of one whorl, the oxidation reduction reaction of a polymer is promoted and the flexible rate at the time of telescopic motion becomes quick.

[0066]
[Effect of the Invention] The flexible component which consists of pi conjugation mold polymeric materials, such as the poly aniline and polypyrrole, if it is in above-mentioned this invention according to claim 1, It consists of the power supply section for impressing an electrical potential difference to this flexible component and the electrical-potential-difference impression section, and the electrolyte for making it flow through a current outside from a flexible component. In the device which a flexible component will elongate if electropositive potential is impressed to the electrical-potential-difference impression section, and a flexible component will contract if electronegative potential is impressed to the electrical-potential-difference impression section

Bias devices, such as a spring which generates the force, are established in the elongation direction at the time of elongation of a flexible component. Although the change of forward potential and negative potential is adjustable, the amount of ion doping of a flexible component increases and a flexible component tends to elongate the power supply section which supplies potential to the electrical-potential-difference impression section if forward potential is impressed to the electrical-potential-difference impression section since it controls the amount of telescopic motion of a flexible component by the absolute value of an electrical-potential-difference value, and polar change. The force of the direction which elongates a flexible component according to bias devices, such as a spring, at this time occurs. The actuator force of the elongation direction in case this uses as an actuator can be discovered. Moreover, in case negative potential is impressed to the electrical-potential-difference impression section and a flexible component contracts, the amount of ion doping of a flexible component decreases, resist the force of a bias device, and a flexible component contracts. The actuator force of the contraction direction can be discovered and the actuator which can carry out actuation of both elongation and contraction can be offered with an easy configuration.

[0067] Moreover, if it is in invention according to claim 2, it adds to the effect of the invention of the claim 1 above-mentioned publication. Since the electrolyte is enclosed with the space which installs the counterelectrode section in the electrical-potential-difference impression section, a flexible component, and its near, forms the covering sections, such as silicon, in the outermost periphery, and is formed between the counterelectrode section and a flexible component. Electrolytic external leakage is prevented and the actuator of a package mold can be offered with an easy configuration.

[0068] Moreover, if it is in invention according to claim 3, since the counterelectrode section is installed in the perimeter of a flexible component in addition to above-mentioned claim 1 or the effect of the invention according to claim 2, it is that the electric field to a flexible component become homogeneity, an oxidation reduction reaction is promoted, and an oxidation reduction reaction is promoted in this way, and telescopic motion of a flexible component is also promoted.

[0069] Moreover, if it is in invention according to claim 4, the actuator which form status change-ization which the counterelectrode section was installed in the electrical-potential-difference impression section, a flexible component, and its near in addition to the effect of the invention given in either above-mentioned claim 1 thru/or claim 3, the counterelectrode followed in footsteps of telescopic motion of a flexible component since the counterelectrode section was the network structure, consequently answered telescopic motion of a flexible component tends to obtain can be offered.

[0070] Moreover, if it is in invention according to claim 5, since in addition to the effect of the invention of the claim 1 above-mentioned publication the electrical-potential-difference impression section is installed in the both ends of a flexible component and performs electrical-potential-difference impression from a power supply section from the both ends of a flexible component, charge grouting velocity becomes quick and the oxidation reduction reaction of a flexible component is also promoted.

[0071] Moreover, in addition to the effect of the invention of the claim 1 above-mentioned publication, if it is in invention according to claim 6, since the contact of the electrical-potential-difference impression section and a flexible component is larger than the electrical conductivity of a flexible component, charge grouting velocity becomes quick and the oxidation reduction reaction of a flexible component is also promoted.

[0072] Moreover, if it is in invention according to claim 7, since the counterelectrode section is installed in the electrical-potential-difference impression section, a flexible component, and its near at either above-mentioned claim 1 thru/or claim 3 in addition to a written effect of the invention, the bias device is carrying out the shape of coiled spring and this bias device serves as the counterelectrode section, a bias device and the counterelectrode section are made to serve a double purpose, and an actuator with few components mark can be offered.

[0073] Moreover, if it is in invention according to claim 8, since in addition to the effect of the invention of the claim 1 above-mentioned publication the covering section which covers the outermost periphery consisted of elastic bodies and serves as the bias device, a covering object makes a bias device serve a double purpose, and can offer an actuator with few components mark.

[0074] Moreover, if it is in invention according to claim 9, since the flexible component which installed and thin-film-ized the counterelectrode section to the core is made into the shape of a roll in addition to the effect of the invention of the claim 1 above-mentioned publication and it arranges around the counterelectrode section. The surface area of an elongation component can be made to be able to raise, a degree of shrinkage can be raised, and electric field can be added to homogeneity by installing the counterelectrode section in a core at the counterelectrode section of the shape of a surrounding roll.

[0075] moreover -- if it is in invention according to claim 10 -- the effect of the invention of the claim 9 above-mentioned publication -- in addition, uniform electric field can be impressed to inside-and-outside both sides of the flexible component which carried out the shape of a roll since the counterelectrode section had been arranged so that a periphery may be surrounded further of the flexible component which carried out the shape of a roll, the oxidation reduction reaction of a flexible component is promoted, and telescopic motion of a flexible component can be promoted as a result.

[0076] Moreover, if it is in invention according to claim 11, since two or more layers the flexible component and the counterelectrode section which carried out the shape of a roll are arranged in addition to the effect of the invention of the claim 10 above-mentioned publication, the pull strength at the time of contraction can be improved.

[0077] Moreover, if it is in invention according to claim 12, since the actuator which arranged the flexible component which carried out the shape of a roll, and the counterelectrode section in the direction of a path is carrying out the shape of a tube in addition to above-mentioned claim 1 or the effect of the invention according to claim 4, the actuator of the shape of a tube expanded and contracted to radial can be offered.

[0078] moreover -- if it is in invention according to claim 13 -- the effect of the invention of the claim 1 above-mentioned

publication -- in addition -- since a negative electrical potential difference is impressed to the flexible component of another side when a forward electrical potential difference is impressed to a flexible component so that one side may contract in while, in case one pair of flexible component is prepared and one side develops for the flexible component of this pair -- elongation and contraction -- difference -- the actuator which can carry out coincidence implementation of the motion can be offered.

[0079] Moreover, if it is in invention according to claim 14, since a flexible component is installed in the both sides of the elastic core material from which the natural condition became a curve configuration in addition to above-mentioned claim 1 or an effect of the invention according to claim 13, curve movement which spreads in radial [of the curved actuator] or narrows is realizable. Moreover, although negative potential will be impressed to the flexible component of another side, it will contract and an actuator carries out curve actuation by this when forward potential is impressed to one flexible component and it elongates by impressing an electrical potential difference between two flexible components. In this case, a bias device for while to develop and for the flexible component which another side contracts promote the crookedness elongation at the time of carrying out crookedness elongation of the flexible component 1 will be constituted. Therefore, the crookedness elongation force as an actuator can be discovered, without needing the special bias device of another components.

[0080] Moreover, if it is in invention according to claim 15, since a flexible component is installed in both the outsides of the elastic core material of the shape of direct [of a center section] in addition to above-mentioned claim 1 or an effect of the invention according to claim 13, an actuator with the crookedness degree of freedom crooked in a longitudinal direction can be offered.

[0081] Moreover, if it is in invention according to claim 16, since in addition to the effect of the invention of the claim 15 above-mentioned publication at least two or more electrical-potential-difference impression sections are prepared along the flexible direction of a flexible component and the change of an electrical-potential-difference impression location is enabled, the actuator which can control change of the rate of crookedness by the easy configuration can be offered.

[0082] Moreover, if it is in invention according to claim 17, it adds to above-mentioned claim 1 or an effect of the invention according to claim 13. Since install a flexible component through the insulating movement transfer section, the electrical-potential-difference impression section is prepared in the insulating movement transfer section of each flexible component, and the edge of the opposite side, reverse potential is impressed to the electrical-potential-difference impression section of each flexible component and the insulating movement transfer section is made to go up and down. The insulating movement transfer section can offer the actuator which carries out vertical migration with an easy configuration. Moreover, the crookedness elongation force as an actuator can be discovered, without the flexible component which another side contracts constituting the bias device for while developing and promoting the elongation at the time of a flexible component developing, therefore needing the bias device of another components.

[0083] Moreover, if it is in invention according to claim 18, since the flexible component is arranged in the both sides of the rigid core material with which it was combined with by the link section and the rigid core material was combined by this link section in addition to above-mentioned claim 1 or the effect of the invention according to claim 13, the actuator which carries out an articular movement and is crooked can be offered. Moreover, the crookedness elongation force as an actuator can be discovered, without the flexible component which another side contracts constituting the bias device for while developing and promoting the crookedness elongation at the time of carrying out crookedness elongation of a flexible component, therefore needing the bias device of another components.

[0084] Moreover, if it is in invention according to claim 19, it adds to the effect of the invention of the claim 1 above-mentioned publication. Since two or more flexible components are prepared, the change section which switches impression of the electrical potential difference to these two or more flexible components is prepared and voltage switching generates the pattern of a flexible component of operation. By changing various electrical-potential-difference impression change patterns to two or more flexible components, coincidence can be made to be able to elongate all flexible components, it can be made to be able to contract, or combination of elongation and contraction is changed, and an actuator with a high degree of freedom can be offered.

[0085] Moreover, if it is in invention according to claim 20, since in addition to the effect of the invention of the claim 1 above-mentioned publication the counterelectrode section is prepared in a core, at least three or more flexible components are installed in the periphery section of the counterelectrode section and impression of the electrical potential difference to three or more flexible components is switched, the actuator which can perform three-dimension crookedness actuation can be offered. Moreover, the crookedness elongation force as an actuator can be discovered, without the flexible component to contract constituting the bias device for promoting the crookedness elongation at the time of carrying out crookedness elongation of the flexible component to elongate, therefore needing the bias device of another components.

[0086] moreover -- if it is in invention according to claim 21 -- the effect of the invention of the claim 1 above-mentioned publication -- in addition, since the counterelectrode section which served as the flexible component to one side of a rigid core material where it was combined by the link section and the rigid core material was combined by this link section, and served as bias devices, such as a spring, to the side of another side has been prepared, it is crooked in a link section part and the actuator with which joint-crookedness is performed can offer -- it comes out. Moreover, components mark are reducible by having made a bias device and the counterelectrode section as which it served serve a double purpose.

[0087] Moreover, if it is in invention according to claim 22, since the tension guide for guiding the abbreviation center section of the flexible component to the link section is prepared in addition to the effect of the invention of the claim 21 above-mentioned publication, the actuator which can perform larger crookedness in the small amount of contraction can be offered in being guided with a tension guide, in case a flexible component contracts.

[0088] Moreover, if it is in invention according to claim 23, it adds to the effect of the invention of the claim 1 above-mentioned

publication. Insert two or more flexible components which have the electrical-potential-difference impression section in the counterelectrode section which carried out tubed, and since between the inner circumference of the counterelectrode section and the external surface of two or more flexible components which have the electrical-potential-difference impression section is an electrolyte in the interior of the tubed counterelectrode section Each flexible component can perform flexible actuation and can consider as the actuator of large direct-acting of the generating force as a whole.

[0089] Moreover, if it is in invention according to claim 24, since the flexible component which arranges and thin-film-ized the counterelectrode section to the core is bent in the shape of a rib in addition to the effect of the invention of invention of the claim 1 above-mentioned publication and it arranges in the periphery section of the counterelectrode section Electric field can be added to a surrounding flexible component at homogeneity by the surface area of a flexible component increasing by the rib, being able to enlarge the generating force at the time of telescopic motion also with the actuator of the same size, and installing the counterelectrode section in a core.

[0090] Moreover, if it is in invention according to claim 25, since it is crooked in the shape of a rib, the counterelectrode section which has been arranged to the core in addition to the effect of the invention of the claim 24 above-mentioned publication The surface area of a flexible component increases by the rib, consequently the generating force at the time of telescopic motion can be enlarged also with the actuator of the same size. The oxidation reduction reaction of a polymer is promoted by bending the counterelectrode section in the shape of a rib, and the flexible rate at the time of telescopic motion becomes quick, consequently the generating force at the time of telescopic motion can offer a large actuator with the quick flexible rate at the time of telescopic motion.

[0091] Moreover, if it is in invention according to claim 26, since it is made spiral and arranges around the counterelectrode, it is the thing [component / which arranges and thin-film-ized the counterelectrode section to the core in addition to the effect of the invention of the claim 1 above-mentioned publication / flexible] which surface area of a flexible component can be enlarged and can enlarge the generating force at the time of telescopic motion also with the actuator of the same size centering on the counterelectrode section.

[0092] Moreover, if it is in invention according to claim 27, in addition to the effect of the invention of the claim 1 above-mentioned publication, the flexible component and the counterelectrode section which were thin-film-ized are made spiral, respectively. Since it has arranged so that the core of both whorls may be common and the whorl of another side may meet the periphery of one whorl By arranging so that can enlarge surface area of a flexible component also with the actuator of the same size, and the generating force at the time of telescopic motion can be enlarged, the core of both whorls may be common and the whorl of another side may meet the periphery of one whorl The oxidation reduction reaction of a polymer is promoted, the flexible rate at the time of telescopic motion becomes quick, and the generating force at the time of telescopic motion can offer consequently] a large actuator with the quick flexible rate at the time of telescopic motion.

[Translation done.]

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(54) 【発明の名称】 アクチュエータ

(57) 【要約】

【課題】 簡単な構成で伸張時にも確実にアクチュエータとしての力を発現できるアクチュエータを提供する。

【解決手段】 ポリアニリン、ポリピロール等のπ共役型高分子材料で構成される伸縮素子1と、該伸縮素子1に電圧を印加するための電源部2及び電圧印加部3と、電流を伸縮素子1から外部に導通させるための電解質4とから成り、電圧印加部3に正の電位を印加すると伸縮素子1が伸張し且つ電圧印加部3に負の電位を印加すると伸縮素子1が収縮する機構を具備している。伸縮素子1に伸張時に伸張方向に力を発生するばね等のバイアス機構5を設ける。電圧印加部3へ電位を供給する電源部2は正電位、負電位の切換えが可変であって電圧値の絶対値及び極性の切換えによって伸縮素子1の伸縮量を制御する。

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【特許請求の範囲】

【請求項1】 ポリアニリン、ポリピロール等の π 共役型高分子材料で構成される伸縮素子と、該伸縮素子に電圧を印加するための電圧印加部と、電流を伸縮素子から外部に導通させるための電解質とから成り、電圧印加部に正の電位を印加すると伸縮素子が伸張し且つ電圧印加部に負の電位を印加すると伸縮素子が収縮する機構において、伸縮素子の伸張時に伸張方向に力を発生するばね等のバイアス機構を設け、電圧印加部へ電位を供給する電源部は正電位、負電位の切換えが可変であって電圧値の絶対値及び極性の切換えによって伸縮素子の伸縮量を制御することを特徴とするアクチュエータ。

【請求項2】 電圧印加部と伸縮素子及びその近傍に対向電極部を設置し、最外周部にシリコン等の被覆部を形成し、対向電極部と伸縮素子との間に形成される空間に電解質を封入して成ることを特徴とする請求項1記載のアクチュエータ。

【請求項3】 対向電極部を伸縮素子の周囲に設置してなることを特徴とする請求項1又は請求項2記載のアクチュエータ。

【請求項4】 電圧印加部と伸縮素子及びその近傍に対向電極部を設置し、対向電極部が網目構造であることを特徴とする請求項1乃至請求項3のいずれかに記載のアクチュエータ。

【請求項5】 電圧印加部が伸縮素子の両端部に設置され、電源部からの電圧印加を伸縮素子の両端部から行うことを特徴とする請求項1記載のアクチュエータ。

【請求項6】 電圧印加部と伸縮素子の接点伸縮素子の電気伝導度よりも大きいことを特徴とする請求項1記載のアクチュエータ。

【請求項7】 電圧印加部と伸縮素子及びその近傍に対向電極部を設置するものであって、バイアス機構がコイルばね状をしていて該バイアス機構が対向電極部を兼ねていることを特徴とする請求項1乃至請求項3のいずれかに記載のアクチュエータ。

【請求項8】 最外周を被覆する被覆部が弾性体で構成されてバイアス機構を兼ねていることを特徴とする請求項1記載のアクチュエータ。

【請求項9】 中心部に対向電極部を設置し、薄膜化した伸縮素子をロール状にして対向電極部の周囲に配置して成ることを特徴とする請求項1記載のアクチュエータ。

【請求項10】 ロール状をした伸縮素子の更に外周を囲むように対向電極部を配置することを特徴とする請求項9記載のアクチュエータ。

【請求項11】 ロール状をした伸縮素子と対向電極部を複数層配置することを特徴とする請求項10記載のアクチュエータ。

【請求項12】 ロール状をした伸縮素子と対向電極部とを径方向に配設したアクチュエータが円管状をしてい

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ることを特徴とする請求項1又は請求項4記載のアクチュエータ。

【請求項13】 伸縮素子を一対設け、この一対の伸縮素子に一方が伸張する際には一方が収縮するように一方の伸縮素子に正の電圧を印加した際には他方の伸縮素子には負の電圧を印加することを特徴とする請求項1記載のアクチュエータ。

【請求項14】 自然状態が湾曲形状となった弾性芯材の両側に伸縮素子を設置することを特徴とする請求項1又は請求項13記載のアクチュエータ。

【請求項15】 中央部の直状の弾性芯材の両外側に伸縮素子を設置することを特徴とする請求項1又は請求項13記載のアクチュエータ。

【請求項16】 伸縮素子の伸縮方向に沿って少なくとも2箇所以上の電圧印加部を設け、電圧印加場所を切換え自在として成ることを特徴とする請求項15記載のアクチュエータ。

【請求項17】 伸縮素子を絶縁運動伝達部を介して設置し、各伸縮素子の絶縁運動伝達部と反対側の端部に電圧印加部を設け、それぞれの伸縮素子の電圧印加部に逆の電位を印加して絶縁運動伝達部を上下させることを特徴とする請求項1又は請求項13記載のアクチュエータ。

【請求項18】 剛性芯材がリンク部により結合され、このリンク部により結合された剛性芯材の両側に伸縮素子を配設して成ることを特徴とする請求項1又は請求項13記載のアクチュエータ。

【請求項19】 2つ以上の伸縮素子を設け、この2つ以上の伸縮素子への電圧の印加を切換える切換え部を設け、電圧切換えにより伸縮素子の動作パターンを生成することを特徴とする請求項1記載のアクチュエータ。

【請求項20】 中心部に対向電極部を設け、対向電極部の外周部に少なくとも3個以上の伸縮素子を設置し、3個以上の伸縮素子への電圧の印加を切換えることを特徴とする請求項1記載のアクチュエータ。

【請求項21】 剛性芯材がリンク部により結合され、このリンク部により結合された剛性芯材の一方の側方に伸縮素子を、他方の側方にばね等のバイアス機構を兼ねた対向電極部を設けて成ることを特徴とする請求項1記載のアクチュエータ。

【請求項22】 リンク部に伸縮素子の略中央部をガイドするための張力ガイドを設けて成ることを特徴とする請求項21記載のアクチュエータ。

【請求項23】 筒状をした対向電極部に、電圧印加部を有する伸縮素子を複数挿入し、筒状の対向電極部の内部において対向電極部の内周と電圧印加部を有する複数の伸縮素子の外面との間が電解質であることを特徴とする請求項1記載のアクチュエータ。

【請求項24】 中心部に対向電極部を配置し、薄膜化した伸縮素子をひだ状に折り曲げて対向電極部の外周部

PCL XL error

Subsystem: KERNEL

Error: IllegalOperatorSequence

Operator: SetColorSpace

Position: 158

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電極部7の外周部に少なくとも3個以上の伸縮素子1を設置し、3個以上の伸縮素子1への電圧の印加を切替えることが好ましい。このような構成とすることで、3次元屈曲動作ができるアクチュエータを提供することができるものである。この場合、収縮する伸縮素子1が、伸張する伸縮素子1の屈曲伸張の際における屈曲伸張を助長するためのバイアス機構5を構成することになり、したがって、別部品のバイアス機構5を必要とすることなく、アクチュエータとしての屈曲伸張力を発現できることになる。

【0025】また、剛性芯材10がリンク部11により結合され、このリンク部11により結合された剛性芯材10の一方の側方に伸縮素子1を、他方の側方にばね等のバイアス機構5を兼ねた対向電極部7を設けることが好ましい。このような構成とすることで、アクチュエータはリンク部11部分で屈曲して、関節的な屈曲が行われる。また、バイアス機構5と兼ねた対向電極部7が兼用してあることで、部品点数を削減できるものである。

【0026】また、リンク部11に伸縮素子1の略中央部をガイドするための張力ガイド13を設けることが好ましい。このような構成とすることで、伸縮素子1が収縮する際に張力ガイド13によりガイドされることで、少ない収縮量でより大きい屈曲ができることになる。

【0027】また、筒状をした対向電極部7に、電圧印加部3を有する伸縮素子1を複数挿入し、筒状の対向電極部7の内部において対向電極部7の内周と電圧印加部3を有する複数の伸縮素子1の外周との間が電解質4であることが好ましい。このような構成とすることで、各伸縮素子1が伸縮動作を行い、全体として発生力の大きい直動のアクチュエータとすることができるものである。

【0028】また、中心部に対向電極部7を配置し、薄膜化した伸縮素子1をひだ状に折り曲げて対向電極部7の外周部に配置することが好ましい。このような構成とすることで、同一サイズのアクチュエータでも伸縮素子1の表面積を大きくできて伸縮時の発生力を大きくすることができるものである。また、中心部に対向電極部7を設置することで、周囲の伸縮素子1に均一に電界を付加できることになる。

【0029】また、中心部に配置した対向電極部7をひだ状に屈曲することが好ましい。このような構成とすることで、同一サイズのアクチュエータでも伸縮素子1の表面積を大きくできて伸縮時の発生力を大きくすることができ、また、対向電極部7もひだ状に折り曲げることでポリマーの酸化還元反応を促進し、伸縮時の伸縮速度が速くなるものである。

【0030】また、中心部に対向電極部7を配置し、薄膜化した伸縮素子1を対向電極部7を中心とした螺旋状にして対向電極の周囲に配置することが好ましい。このような構成とすることで、同一サイズのアクチュエータでも伸縮素子1の表面積を大きくできて伸縮時の発生力

を大きくすることができるものである。

【0031】また、薄膜化した伸縮素子1及び対向電極部7をそれぞれ螺旋状にして、両渦巻きの中心が共通で且つ一方の渦巻きの外周に他方の渦巻きが沿うように配置することが好ましい。このような構成とすることで、同一サイズのアクチュエータでも伸縮素子1の表面積を大きくできて伸縮時の発生力を大きくすることができ、また、両渦巻きの中心が共通で且つ一方の渦巻きの外周に他方の渦巻きが沿うように配置することで、ポリマーの酸化還元反応を促進し、伸縮時の伸縮速度が速くなるものである。

【0032】

【発明の実施の形態】以下、本発明を添付図面に示す実施形態に基づいて説明する。

【0033】図1には本発明のアクチュエータの原理図が示してある。本発明のアクチュエータはポリアニリン、ポリピロール等のπ共役型高分子材料で構成された伸縮素子1と、該伸縮素子1に電圧を印加するための電圧印加部2及び電圧印加部3と、電流を伸縮素子1から外部に導通させるための電解質4と、伸縮素子1の伸張時に伸張方向に力を発生するばね等のバイアス機構5を設けて構成したものである。ここで、本発明に使用する電解質4としては陰イオンとしてある程度の分子量を有するもの。例えば、 SO_4^{2-} を生じる H_2SO_4 、 Na_2SO_4 、 Cl^- を生じる HCl や、 F^- を生じる HPF_6 、 HBF_4 などが使用できるものである。

【0034】そして、電圧印加部3に正の電位の電圧を印加すると酸化還元反応により伸縮素子のイオンドープ量が增大して伸縮素子1が伸張し、また、逆に電圧印加部3に負の電位の電圧を印加すると伸縮素子のイオンドープ量が減少して伸縮素子1が収縮するようになっている。

【0035】しかして、本発明のアクチュエータは、伸縮素子1の伸張時に伸張方向に力を発生するばね等のバイアス機構5を設けてあるので、図1(b)のように、電圧印加部3に正の電位の電圧を印加して伸縮素子1が伸張する際、ばね等のバイアス機構5により伸張方向の力が作用して伸張時におけるアクチュエータ力を発現できることになる。ここで、実施形態としてバイアス機構5がばねの場合、伸縮素子1の伸張時にはばねが自然長に戻ろうとする力が伸張方向に発生するのである。一方、図1(c)のように、電圧印加部3に負の電位の電圧を印加して伸縮素子1が収縮する際、ばね等のバイアス機構5による伸張方向の力に抗する引張り力により伸縮素子1が収縮し、収縮時におけるアクチュエータ力を発現するものである。

【0036】図2にはバイアス機構の機能の説明が示してある。すなわち、図2(a)は電圧印加部3に電圧を印加していない無負荷状態を示し、ばね等のバイアス機構5は伸縮素子1を伸張させる方向に力を作用してい

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る。図2(b)は電圧印加部3に正の電位の電圧を印加して伸縮素子1が伸張した状態を示し、ばね等のバイアス機構5は伸縮素子1を伸張させる方向に力を作用している。図2(c)は電圧印加部3に負の電位の電圧を印加して伸縮素子1が収縮した状態を示し、ばね等のバイアス機構5に抗して伸縮素子1が収縮方向に引張り力を発現している。これにより、伸縮素子1の伸張時にバイアス機構5の伸張方向への力が加わって伸張方向におけるアクチュエータ力を発現すると共に収縮時には引張り力を発現して伸張時及び収縮時共アクチュエータ力を発現できるものである。

【0037】図3(a)は電圧と伸縮量との関係を示すグラフであり、このグラフから明かなように、伸縮素子1に印加する電圧の絶対値により伸縮量の絶対値を変化させることができる。また、図3(b)は極性による伸縮方向の反転を説明するための説明図であり、伸張、収縮の切換えは伸縮素子1に印加する電圧の極性を変えることで実現するものであり、電圧印加部3に正の電位の電圧を印加することで伸縮素子1が伸張し、電圧印加部3に負の電位の電圧を印加することで伸縮素子1が収縮するものであり、電圧の極性を変えるという簡単な制御で伸張、収縮の制御ができるアクチュエータが提供できるのである。

【0038】図4には本発明のアクチュエータの一実施形態が示してある。変形性を有するシリコン等により形成した筒状の被覆部6内に一端部に電圧印加部3を設けた伸縮素子1を配設し、筒状の被覆部6の上下開口部を閉塞部15により閉塞し、更に、伸縮素子1の外側に伸縮素子1の伸張時に伸張させる方向に力を与えるバイアス機構5を構成するばねを配設し、また被覆部6内に上下にわたって対向電極部7を配設し、対向電極部7と伸縮素子1との間に形成される空間(つまり被覆部2内)に電解質4を封入してある。そして、電源部2に電圧印加部3と対向電極部7とが接続してある。

【0039】しかし、電圧印加部3に正電位の電圧を印加し、対向電極部7に負の電位を印加すると、伸縮素子1が伸張する(このときバイアス機構5により伸張方向の力が作用して伸張方向におけるアクチュエータ力を発現する)。また、電圧印加部3に負電位の電圧を印加し、対向電極部7に正の電位を印加すると、伸縮素子1が収縮してバイアス機構5による伸張方向の力に抗する引張り力が生じて、収縮方向におけるアクチュエータ力を発現するものである。本実施形態においては、簡単な構成で電解質4が外部に漏洩しないようにでき、また、パッケージ型のアクチュエータを構成することができるものである。

【0040】図5には本発明のアクチュエータの他の実施形態が示してある。本実施形態の基本的構成は前述の図4に示す実施形態と同様であるが、対向電極部7を伸縮素子1の周囲に配置した点が図4に示すものと異なる。

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る。すなわち、本実施形態においては、筒状をした被覆部6が円筒形状をしており、この円筒形状をした被覆部6の内周面に沿って円筒状をした対向電極部7が配設してある。本実施形態におけるアクチュエータとしての動作は前述の図4に示す実施形態と同様なので説明を省略するが、本実施形態においては、対向電極部7が伸縮素子1の周囲に設置してあるので、伸縮素子1への電界が均一になり酸化還元反応が促進され、このように酸化還元反応が促進されることで、伸縮素子1の伸縮も促進されることになる。

【0041】図6には本発明のアクチュエータの更に他の実施形態が示してある。本実施形態においては、対向電極部7が図6(c)に示すように伸縮自在な網目構造となっている点が異なるのみで、他の構成は図4や図5に示す実施形態と同じ構成となっており、アクチュエータとしての動作も同じなので重複する説明は省略する。しかし、本実施形態においては、対向電極部7を網目構造とすることで、アクチュエータが伸縮していない場合には図6(c)の状態であるが、アクチュエータが収縮した場合には図6(d)のように網目構造の対向電極部7が追随して収縮し、アクチュエータが伸張した場合には図6(e)のように網目構造の対向電極部7が追随して伸張するものである。このように、電圧印加部3と伸縮素子1及びその近傍に対向電極部7を設置し、対向電極部7が網目構造とすることで、簡単な構成の対向電極部7で伸縮素子1の伸縮に追随して形状変形することができるものである。なお、図6では網目構造の対向電極部7が円筒状をしている例を示しているが、網目構造の対向電極部7が片状をしたものであってもよい。

【0042】図7には本発明のアクチュエータの更に他の実施形態が示してある。本実施形態においては電圧印加部3を伸縮素子1の両端部に設置し、電源部2からの電圧印加を伸縮素子1の両端部から行うことに特徴があり、他の構成は図4乃至図6に示すいずれの実施形態と同じ構成となっているので、重複する構成の説明は省略する。また、アクチュエータとしての動作も同じ動作を行うので重複する説明は省略する。しかし、本実施形態においては、電圧印加部3を伸縮素子1の両端部に設置し、電源部2からの電圧印加を伸縮素子1の両端部から行うので、電荷注入速度が速くなり、伸縮素子1の酸化還元反応も促進され、伸縮素子1の伸縮の速度が速くなるものである。

【0043】ところで、前述の図4乃至図7に示すいずれの実施形態においても、電圧印加部3と伸縮素子1の接点16を伸縮素子1の電気伝導度よりも大きい銅、銀等の金属により構成するとよい(図8参照)。このような構成とすることで、電荷注入速度が速くなり、伸縮素子1の酸化還元反応も促進され、伸縮素子1の伸縮の速度が速くなるものである。構成、動作については前述の各実施形態と同様なので、重複する説明は省略する。

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【0044】図9には本発明の更に他の実施形態が示してある。本実施形態において、対向電極部7、バイアス機構5を除く他の構成は図4乃至図8のいずれかに示す実施形態と同じである。したがって、図4乃至図8のいずれかに示す実施形態と共通する構成の説明及びアクチュエータとしての動作の説明は重複するので省略し、異なる構成についてのみ説明する。すなわち、本実施形態においては、金属製のコイルばねによりバイアス機構5を構成することで、バイアス機構5に対向電極部7を兼用させた点に本実施形態の特徴がある。これにより、バイアス機構5と対向電極部7とを兼用で部品点数の削減ができるものである。

【0045】図10には本発明の更に他の実施形態が示してある。本実施形態において、最外周を被覆する被覆部6、バイアス機構5を除く他の構成は図4乃至図8のいずれかに示す実施形態と同じである。したがって、図4乃至図8のいずれかに示す実施形態と共通する構成の説明及びアクチュエータとしての動作の説明は重複するので省略し、異なる構成についてのみ説明する。すなわち、本実施形態においては、最外周を被覆する被覆部6がゴムのような弾性体で構成されてバイアス機構5を兼ねた点に特徴がある。これにより、被覆部6とバイアス機構5とを兼用で部品点数の削減ができるものである。ここで、バイアス機構5を構成するゴム等の弾性体に伸張方向に延びようとする初期抵抗を与えて設置することで、被覆部6に伸縮素子1の伸張時に伸張方向に力を発生させるバイアス機構5としての機能を付与できるものである。

【0046】次に、本発明の更に他の実施形態を図11に基づいて説明する。図5乃至図8に示す実施形態においては中心部に伸縮素子1を配置し、対向電極部7を伸縮素子1の周囲に配置した例であるが、図11に示す実施形態においては中心部に対向電極部7を設置し、薄膜化した伸縮素子1をロール状にして対向電極部7の周囲に配置した点が図5乃至図8に示す実施形態と構成が異なり、他の構成は図5乃至図8のいずれかに示す実施形態と同様であり、またアクチュエータとしての動作も共通しているので、共通する構成及び動作の説明は省略する。しかし、薄膜化した伸縮素子1をロール状にして対向電極部7の周囲に配置することで、同一サイズのアクチュエータでも伸縮素子1の断面積を大きくできて伸縮時の発生力を大きくすることができるものである。また、中心部に対向電極部7を設置することで、周囲の伸縮素子1に均一に電界を印加できることになる。

【0047】次に、本発明の更に他の実施形態を図12に基づいて説明する。本実施形態においては、上記図11に示す実施形態において、ロール状に設置された伸縮素子1の外周を囲むように更に対向電極部7を追加設置したものであり、他の構成、動作は図11に示す実施形態と同様であるので省略する。本実施形態においては、

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伸縮素子1への電圧印加が表裏均一となり、伸縮素子1の酸化還元反応が促進され、結果的に伸縮素子1の伸縮が促進されることになる。

【0048】次に、本発明の更に他の実施形態を図13に基づいて説明する。本実施形態においては、上記した図12に示す実施形態において、ロール状に設置された伸縮素子1と対向電極部7とを複数層配置したものであり、他の構成、動作は図12に示す実施形態と同様であるので省略する。本実施形態においては、すべての層の伸縮素子1が伸縮促進され且つ伸縮素子1の断面積が増大するので、伸縮方向の発生力がアップすることになる。

【0049】次に、本発明の更に他の実施形態を図14に基づいて説明する。本実施形態においては、ロール状をした伸縮素子1と対向電極部7とを径方向に配設したアクチュエータが円筒状をしている。つまり、図14においては円筒状のアクチュエータの内周面部と外周面部とがロール状をした弾性を有する被覆部6により構成しており、両内外周部の被覆部6間に電圧印加部3を設けたロール状をした伸縮素子1とロール状をした対向電極部7とを配設し、両内外周部の被覆部6間の上下端部間を閉塞し、また、内外周部の被覆部6間に電解質4を封入してある。そして、本実施形態においては、電圧印加部3に正電位の電圧を印加し、対向電極部7に負の電位を印加すると、ロール状の伸縮素子1が半径方向に伸張し、逆に、電圧印加部3に負電位の電圧を印加し、対向電極部7に正の電位を印加すると、ロール状の伸縮素子1が半径方向に収縮するものである。ここで、本実施形態においては図示を省略しているが、伸縮素子1の半径方向への伸張時に伸張方向に力を発生するばね等のバイアス機構が設けてあり、伸張時に半径方向にアクチュエータ力を発現できるものである。このように、円筒状のアクチュエータを半径方向に伸縮させることができるので、例えば、指、腕等の圧迫マッサージ、血圧計等として利用することができるものである。

【0050】次に、図15には本発明の他の実施形態の原理図が示してある。すなわち、本実施形態においては電圧印加部3を設けた伸縮素子1を二対設け、両伸縮素子1間に電解質4を封入したものであり、一方の伸縮素子1の電圧印加部3に正電位の電圧が印加された際には他方の電圧印加部3に負電位が印加されるように両電圧印加部3をそれぞれ電源部2に接続したものである。そして、上記一方の伸縮素子1の電圧印加部3に正電位の電圧を印加し、他方の伸縮素子1の電圧印加部3に負電位の電圧を印加した場合、一方の伸縮素子1が伸張し、他方の伸縮素子1が収縮することになり、一つのアクチュエータで伸張と収縮という相反する動きを同時に実現できることになる。

【0051】この原理を応用した一実施形態を図16に示している。本実施形態においては、自然状態が弧状に

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湾曲した形状をした弾性芯材8の両側に弧状に湾曲した伸縮素子1を配置し、この伸縮素子1に電圧印加部3を設け、アクチュエータの外周部を被覆部6で被覆し、更に、弧状をしたアクチュエータの両端部を閉塞部15で閉塞し、内部に電解質4を封入したものである。しかし、一方の伸縮素子1の電圧印加部3に正電位の電圧を印加し、他方の伸縮素子1の電圧印加部3に負電位の電圧を印加した場合、一方の弧状をした伸縮素子1が伸張し、他方の弧状をした伸縮素子1が収縮することになり、印加する電圧の電位を逆にすると上記と逆の動作をし、これにより弧状をしたアクチュエータが半径方向に広がったり、収縮したりする湾曲動作をする(図16の矢印方向に動作する)ものである。上記のように、2つの伸縮素子1間に電圧を印加することで、一方の伸縮素子1に正電位を印加して伸張した場合に、他方の伸縮素子1に負電位が印加されて収縮することになり、これによりアクチュエータは湾曲動作をするのであるが、この場合、他方の収縮する伸縮素子1が、伸張する一方の伸縮素子1の屈曲伸張する際における屈曲伸張を助長するためのバイアス機構5を構成することになり、したがって、別部品の特別なバイアス機構5を必要とすることなく、アクチュエータとしての屈曲伸張力を発現できることになる。

【0052】図17には図15に示すものの原理を応用した他の実施形態が示してある。すなわち、中央部の直状の弾性芯材8の両外側に上端部に電圧印加部3を設けた伸縮素子1を設置し、外周を被覆部6で被覆し、上端部開口部を閉塞部15で閉塞し、内部に電解質4を封入してアクチュエータを構成したものである。しかし、一方の伸縮素子1の電圧印加部3に正電位の電圧を印加し、他方の伸縮素子1の電圧印加部3に負電位の電圧を印加した場合、一方の伸縮素子1が伸張し、他方の弧状をした伸縮素子1が収縮することになり、印加する電圧の電位を逆にすると上記と逆の動作をし、これにより図17の矢印のようにアクチュエータが左右に首振り運動をするように屈曲するものである。上記のように、中央部の直状の弾性芯材8の両外側に上端部に電圧印加部3を設けた伸縮素子1を設置し、2つの伸縮素子1間に電圧を印加することで、一方の伸縮素子1に正電位を印加して伸張した場合に、他方の伸縮素子1に負電位が印加されて収縮することになり、これによりアクチュエータは屈曲するものである。この場合、他方の収縮する伸縮素子1が、伸張する一方の伸縮素子1の屈曲伸張する際における屈曲伸張を助長するためのバイアス機構5を構成することになり、したがって、別部品のバイアス機構5を必要とすることなく、アクチュエータとしての屈曲伸張力を発現できることになる。

【0053】図18には図15に示すものの原理を応用した更に他の実施形態が示してある。すなわち、図18に示す本実施形態は、図17に示す実施形態において伸

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縮素子1の伸縮方向に沿って少なくとも2箇所以上の電圧印加部3を設けたものである。本実施形態のアクチュエータの基本的な動作は図17に示すものと同じであって、アクチュエータが左右に首振り運動をするように屈曲するものである。そして、各電圧印加部3と電源部2とを接続する並列回路部にはそれぞれスイッチ20が設けてあり、伸縮方向に沿って複数設けた電圧印加部3に接続されたこれらのスイッチのオン、オフ切換えを選択することで、電圧印加場所を切換えるのである。伸縮素子1の伸縮量は電圧印加場所により異なるので、結果的にアクチュエータの屈曲率を制御できることになる。

【0054】図19には本発明の他の実施形態が示してある。本実施形態では、伸縮素子1を絶縁運動伝達部9を介して設置し、各伸縮素子1の絶縁運動伝達部9と反対側の端部に電圧印加部3を設け、外周を被覆部6で被覆し、上下両端開口部を閉塞部15で閉塞し、内部に電解質4を封入してアクチュエータを構成してある。しかし、この実施形態においては、一方の伸縮素子1に正の電位を印加し、他方の伸縮素子1に負の電位を印加することで、一方の伸縮素子1が伸張し、他方の伸縮素子1が収縮し、これにより絶縁運動伝達部9が上下運動を行うものである。この場合、他方の収縮する伸縮素子1が、伸張する一方の伸縮素子1の伸張する際における伸張を助長するためのバイアス機構5を構成することになり、したがって、別部品のバイアス機構5を必要とすることなく、アクチュエータとしての直線伸張力を発現できることになる。

【0055】図20には本発明の他の実施形態が示してある。本実施形態においては、上下の剛性芯材10がリンク部11により結合しており、このリンク部11により結合された剛性芯材10の両側にそれぞれ電圧印加部3を設けた伸縮素子1を配設し、外周を被覆部6で被覆し、上下両端開口部を閉塞部15で閉塞し、内部に電解質4を封入してアクチュエータを構成してある。しかし、この実施形態においては、一方の伸縮素子1に正電位を印加して伸張した場合に、他方の伸縮素子1に負電位が印加されて収縮することになり、これによりアクチュエータはリンク部11部分で屈曲して、関節的な屈曲が行われる。この場合、他方の収縮する伸縮素子1が、伸張する一方の伸縮素子1の屈曲伸張する際における屈曲伸張を助長するためのバイアス機構5を構成することになり、したがって、別部品のバイアス機構5を必要とすることなく、アクチュエータとしての屈曲伸張力を発現できることになる。このように本実施形態においては関節運動をするアクチュエータを提供できるものである。

【0056】次に、図21に本発明の更に他の実施形態の原理図が示してある。すなわち、本実施形態においては、2つ以上の伸縮素子1を設け、この2つ以上の伸縮素子1への電圧の印加を切換える切換え部12を設け、

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り、伸縮素子の酸化還元反応も促進されるものである。

【0071】また、請求項6記載の発明にあっては、上記請求項1記載の発明の効果に加えて、電圧印加部と伸縮素子の接点が伸縮素子の電気伝導度よりも大きいので、電荷注入速度が速くなり、伸縮素子の酸化還元反応も促進されるものである。

【0072】また、請求項7記載の発明にあっては、上記請求項1乃至請求項3のいずれかに記載の発明の効果に加えて、電圧印加部と伸縮素子及びその近傍に対向電極部を設置するものであって、バイアス機構がコイルはね状をしていて該バイアス機構が対向電極部を兼ねているので、バイアス機構と対向電極部とを兼用して部品点数の少ないアクチュエータを提供できるものである。

【0073】また、請求項8記載の発明にあっては、上記請求項1記載の発明の効果に加えて、最外周を被覆する被覆部が導性体で構成されてバイアス機構を兼ねているので、被覆部がバイアス機構を兼用して部品点数の少ないアクチュエータを提供できるものである。

【0074】また、請求項9記載の発明にあっては、上記請求項1記載の発明の効果に加えて、中心部に対向電極部を設置し、薄膜化した伸縮素子をロール状にして対向電極部の周囲に配置してあるので、伸縮素子の表面積をアップさせて伸縮率を向上させることができるものであり、また、中心部に対向電極部を設置することで周囲のロール状の対向電極部に均一に電界を付加できるものである。

【0075】また、請求項10記載の発明にあっては、上記請求項9記載の発明の効果に加えて、ロール状をした伸縮素子の更に外周を囲むように対向電極部を配置するので、ロール状をした伸縮素子の内外両面に均一な電界を印加できて、伸縮素子の酸化還元反応が促進され、結果的に伸縮素子の伸縮を促進することができるものである。

【0076】また、請求項11記載の発明にあっては、上記請求項10記載の発明の効果に加えて、ロール状をした伸縮素子と対向電極部を複数層配置するので、収縮時の引張り力を向上することができるものである。

【0077】また、請求項12記載の発明にあっては、上記請求項1又は請求項4記載の発明の効果に加えて、ロール状をした伸縮素子と対向電極部とを径方向に配設したアクチュエータが円筒状をしているので、半径方向に膨張、収縮する円筒状のアクチュエータを提供できるものである。

【0078】また、請求項13記載の発明にあっては、上記請求項1記載の発明の効果に加えて、伸縮素子を一対設け、この一対の伸縮素子に一方が伸張する際には一方が収縮するように一方の伸縮素子に正の電圧を印加した際には他方の伸縮素子には負の電圧を印加するので、伸張と収縮の相異なる動きを同時実現できるアクチュエータを提供することができるものである。

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【0079】また、請求項14記載の発明にあっては、上記請求項1又は請求項13記載の発明の効果に加えて、自然状態が湾曲形状となった弾性芯材の両側に伸縮素子を設置するので、湾曲したアクチュエータの半径方向に広がったり、狭まったりする湾曲運動を実現できるものである。また2つの伸縮素子間に電圧を印加することで、一方の伸縮素子に正電位を印加して伸張した場合に、他方の伸縮素子に負電位が印加されて収縮することになり、これによりアクチュエータは湾曲動作をするのであるが、この場合、他方の収縮する伸縮素子が、伸張する一方の伸縮素子1の屈曲伸張する際における屈曲伸張を助長するためのバイアス機構を構成することになり、したがって、別部品の特別なバイアス機構を必要とすることなく、アクチュエータとしての屈曲伸張力を発現できるものである。

【0080】また、請求項15記載の発明にあっては、上記請求項1又は請求項13記載の発明の効果に加えて、中央部の直状の弾性芯材の両外側に伸縮素子を設置するので、左右方向に屈曲する屈曲自由度のあるアクチュエータを提供できるものである。

【0081】また、請求項16記載の発明にあっては、上記請求項15記載の発明の効果に加えて、伸縮素子の伸縮方向に沿って少なくとも2箇所以上の電圧印加部を設け、電圧印加場所を切換え自在としてあるので、簡単な構成で屈曲率の変化を制御できるアクチュエータを提供することができるものである。

【0082】また、請求項17記載の発明にあっては、上記請求項1又は請求項13記載の発明の効果に加えて、伸縮素子を絶縁運動伝達部を介して設置し、各伸縮素子の絶縁運動伝達部と反対側の端部に電圧印加部を設け、それぞれの伸縮素子の電圧印加部に逆の電位を印加して絶縁運動伝達部を上下させるので、簡単な構成で絶縁運動伝達部が上下移動するアクチュエータを提供できるものである。また、他方の収縮する伸縮素子が、伸張する一方の伸縮素子の伸張する際における伸張を助長するためのバイアス機構を構成することになり、したがって、別部品のバイアス機構を必要とすることなく、アクチュエータとしての屈曲伸張力を発現できるものである。

【0083】また、請求項18記載の発明にあっては、上記請求項1又は請求項13記載の発明の効果に加えて、剛性芯材がリンク部により結合され、このリンク部により結合された剛性芯材の両側に伸縮素子を配設してあるので、関節運動して屈曲するアクチュエータを提供できるものである。また、他方の収縮する伸縮素子が、伸張する一方の伸縮素子の屈曲伸張する際における屈曲伸張を助長するためのバイアス機構を構成することになり、したがって、別部品のバイアス機構を必要とすることなく、アクチュエータとしての屈曲伸張力を発現できるものである。

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【0084】また、請求項19記載の発明にあつては、上記請求項1記載の発明の効果に加えて、2つ以上の伸縮素子を設け、この2つ以上の伸縮素子への電圧の印加を切替える切替部を設け、電圧切替えにより伸縮素子の動作パターンを生成するので、2つ以上の伸縮素子への電圧印加切替えパターンを種々変えることで、すべての伸縮素子を同時に伸張させたり、収縮させたり、あるいは、伸張、収縮の組み合わせを変えたりして自由度の高いアクチュエータを提供できるものである。

【0085】また、請求項20記載の発明にあつては、上記請求項1記載の発明の効果に加えて、中心部に対向電極部を設け、対向電極部の外周部に少なくとも3個以上の伸縮素子を設置し、3個以上の伸縮素子への電圧の印加を切替えるので、3次元屈曲動作ができるアクチュエータを提供することができるものである。また、収縮する伸縮素子が、伸張する伸縮素子の屈曲伸張する際における屈曲伸張を助長するためのバイアス機構を構成することになり、したがって、別部品のバイアス機構を必要とすることなく、アクチュエータとしての屈曲伸張力を発現できることになる。

【0086】また、請求項21記載の発明にあつては、上記請求項1記載の発明の効果に加えて、剛性芯材がリンク部により結合され、このリンク部により結合された剛性芯材の一方の側方に伸縮素子を、他方の側方にはね等のバイアス機構を兼ねた対向電極部を設けてあるので、リンク部部分で屈曲して、関節的な屈曲が行われるアクチュエータを提供できるものである。また、バイアス機構と兼ねた対向電極部が兼用してあることで、部品点数を削減できるものである。

【0087】また、請求項22記載の発明にあつては、上記請求項21記載の発明の効果に加えて、リンク部に伸縮素子の略中央部をガイドするための張力ガイドを設けてあるので、伸縮素子が収縮する際に張力ガイドによりガイドされることで、少ない収縮量でより大きい屈曲ができるアクチュエータを提供することができるものである。

【0088】また、請求項23記載の発明にあつては、上記請求項1記載の発明の効果に加えて、筒状をした対向電極部に、電圧印加部を有する伸縮素子を複数挿入し、筒状の対向電極部の内部において対向電極部の内周と電圧印加部を有する複数の伸縮素子の外面との間が電解質であるので、各伸縮素子が伸縮動作を行い、全体として発生力の大きい直動のアクチュエータとすることができるものである。

【0089】また、請求項24記載の発明にあつては、上記請求項1記載の発明の効果に加えて、中心部に対向電極部を配置し、薄膜化した伸縮素子をひだ状に折り曲げて対向電極部の外周部に配置するので、ひだにより伸縮素子の表面積が増大し、この結果、同一サイズのアクチュエータでも伸縮時の発生力を大きくすること

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ができ、また、中心部に対向電極部を設置することで、周囲の伸縮素子に均一に電界を付加できるものである。

【0090】また、請求項25記載の発明にあつては、上記請求項24記載の発明の効果に加えて、中心部に配置した対向電極部をひだ状に屈曲しているので、ひだにより伸縮素子の表面積が増大し、この結果、同一サイズのアクチュエータでも伸縮時の発生力を大きくすることができ、対向電極部もひだ状に折り曲げることでポリマーの酸化還元反応を促進し、伸縮時の伸縮速度が速くなり、この結果、伸縮時の発生力が大きく且つ伸縮時の伸縮速度の速いアクチュエータを提供できるものである。

【0091】また、請求項26記載の発明にあつては、上記請求項1記載の発明の効果に加えて、中心部に対向電極部を配置し、薄膜化した伸縮素子を対向電極部を中心とした螺旋状にして対向電極の周囲に配置してあるので、同一サイズのアクチュエータでも伸縮素子の表面積を大きくできて伸縮時の発生力を大きくすることができるものである。

【0092】また、請求項27記載の発明にあつては、上記請求項1記載の発明の効果に加えて、薄膜化した伸縮素子及び対向電極部をそれぞれ螺旋状にして、両渦巻きの中心が共通で且つ一方の渦巻きの外周に他方の渦巻きが沿うように配置したので、同一サイズのアクチュエータでも伸縮素子の表面積を大きくできて伸縮時の発生力を大きくすることができ、また、両渦巻きの中心が共通で且つ一方の渦巻きの外周に他方の渦巻きが沿うように配置することで、ポリマーの酸化還元反応を促進し、伸縮時の伸縮速度が速くなるものであり、この結果、伸縮時の発生力が大きく且つ伸縮時の伸縮速度の速いアクチュエータを提供できるものである。

【図面の簡単な説明】

【図1】(a)は本発明の原理図であり、(b)は伸縮素子の伸張を示す説明図であり、(c)は伸縮素子の収縮を示す説明図である。

【図2】(a)乃至(c)は同上のバイアス機構の作用説明図である。

【図3】(a)は同上の電圧と伸縮量の関係を示すグラフであり、(b)は極性による伸縮方向の反転を説明する説明図である。

【図4】本発明の一実施形態を示し、(a)は概略正面断面図であり、(b)は概略平面断面図である。

【図5】本発明の他の実施形態を示し、(a)は概略正面断面図であり、(b)は概略平面断面図である。

【図6】本発明の更に他の実施形態を示し、(a)は概略正面断面図であり、(b)は概略平面断面図であり、(c)は網目構造の対向電極を示す斜視図であり、(d)は網目構造の対向電極の収縮状態を示す斜視図であり、(e)は網目構造の対向電極の伸張状態を示す斜視図である。

【図7】本発明の更に他の実施形態の概略正面断面図で

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ある。

【図8】本発明の更に他の実施形態の概略正面断面図である。

【図9】本発明の更に他の実施形態の概略正面断面図である。

【図10】(a)は本発明の更に他の実施形態の伸張時の概略正面断面図であり、(b)は収縮時の概略正面断面図である。

【図11】本発明の更に他の実施形態を示し、(a)は概略正面断面図であり、(b)は概略平面断面図である。

【図12】本発明の更に他の実施形態を示し、(a)は概略正面断面図であり、(b)は概略平面断面図である。

【図13】本発明の更に他の実施形態を示し、(a)は概略正面断面図であり、(b)は概略平面断面図である。

【図14】本発明の更に他の実施形態を示す概略平面断面図である。

【図15】本発明の更に他の実施形態の原理図である。

【図16】本発明の更に他の実施形態の概略断面図である。

【図17】本発明の更に他の実施形態の概略正面断面図である。

【図18】本発明の更に他の実施形態の概略正面断面図である。

【図19】本発明の更に他の実施形態の概略正面断面図である。

【図20】(a)は本発明の更に他の実施形態を示す正面断面図であり、(b)は屈曲状態を示す正面断面図である。

【図21】本発明の更に他の実施形態の原理図である。

【図22】(a)は本発明の更に他の実施形態を示す平面断面図であり、(b)は屈曲を示す斜視図である。 *

*【図23】(a)は本発明の更に他の実施形態を示す正面断面図であり、(b)は屈曲状態を示す正面断面図である。

【図24】本発明の更に他の実施形態を示す屈曲状態を示す正面断面図である。

【図25】本発明の更に他の実施形態を示し、(a)は概略平面断面図であり、(b)は概略正面断面図である。

【図26】本発明の更に他の実施形態を示し、(a)は概略平面断面図であり、(b)は概略正面断面図である。

【図27】本発明の更に他の実施形態を示し、(a)は概略平面断面図であり、(b)は概略正面断面図である。

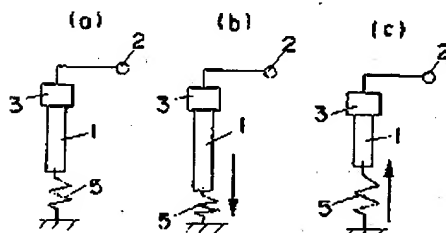
【図28】本発明の更に他の実施形態を示し、(a)は概略平面断面図であり、(b)は概略正面断面図である。

【図29】本発明の更に他の実施形態を示し、(a)は概略平面断面図であり、(b)は概略正面断面図である。

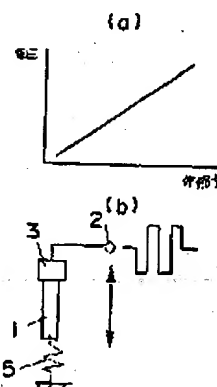
【符号の説明】

- 1 伸縮素子
- 2 電源部
- 3 電圧印加部
- 4 電解質
- 5 バイアス機構
- 6 被覆部
- 7 対向電極部
- 8 弾性芯材
- 9 絶縁運動伝達部
- 10 剛性芯材
- 11 リンク部
- 12 切換部
- 13 張力ガイド

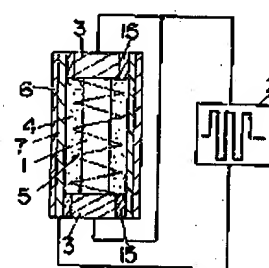
【図2】



【図3】



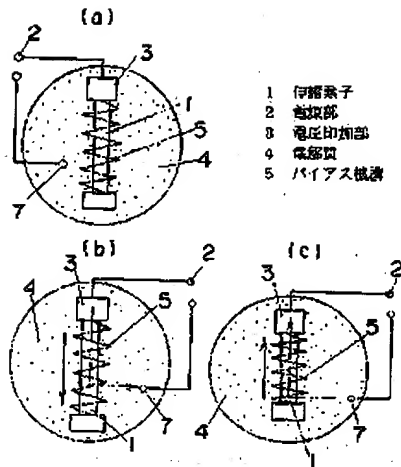
【図7】



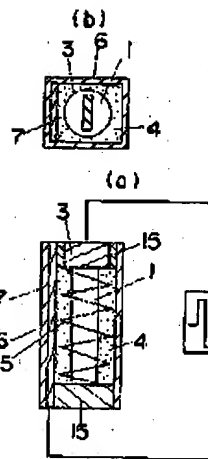
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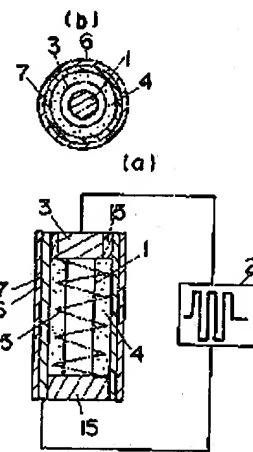
【図1】



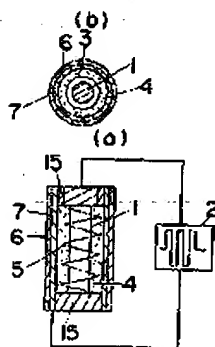
【図4】



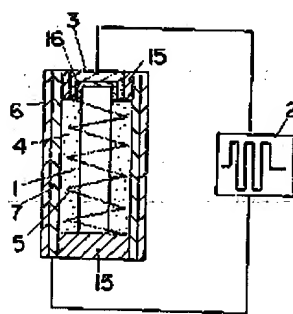
【図5】



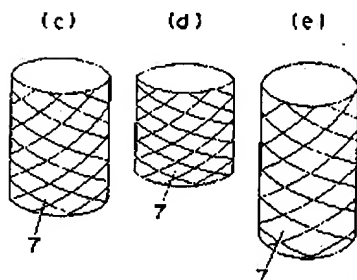
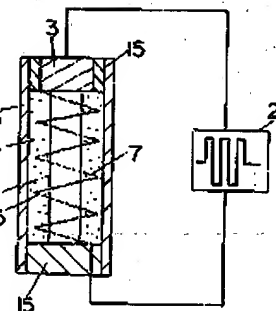
【図6】



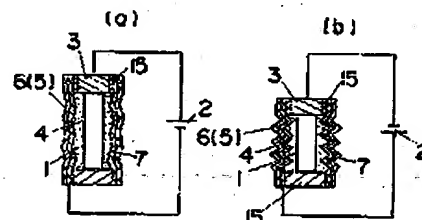
【図8】



【図9】



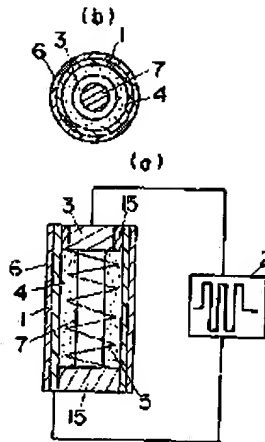
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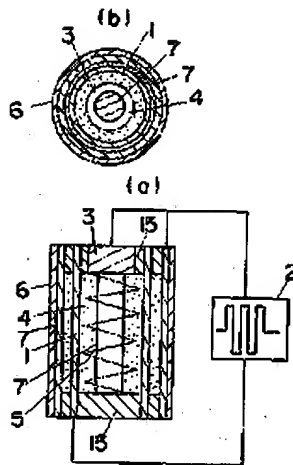
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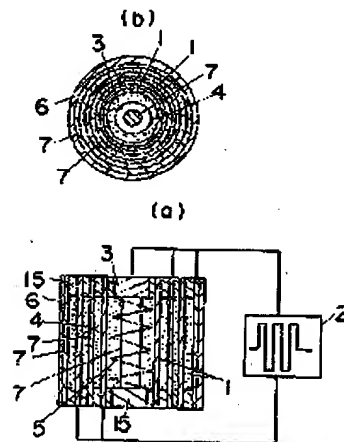
【図11】



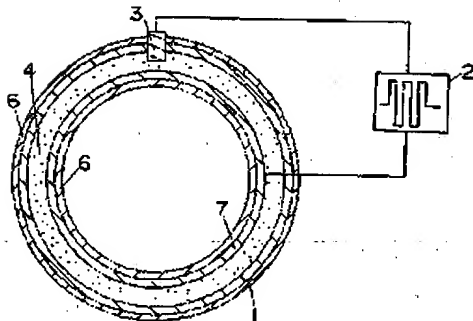
【図12】



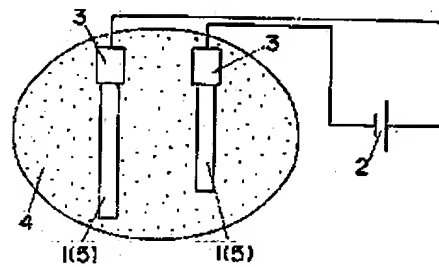
【図13】



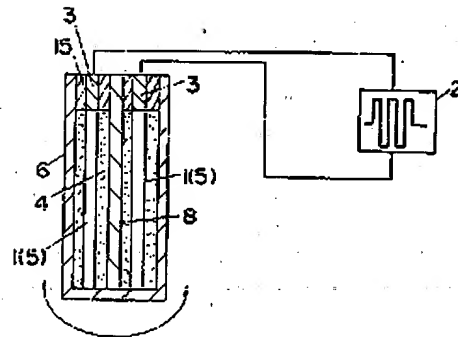
【図14】



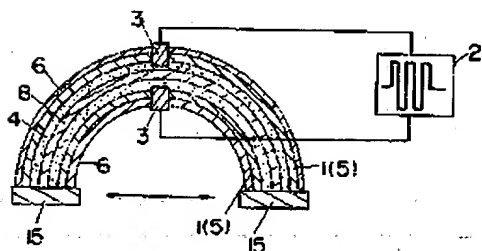
【図15】



【図17】



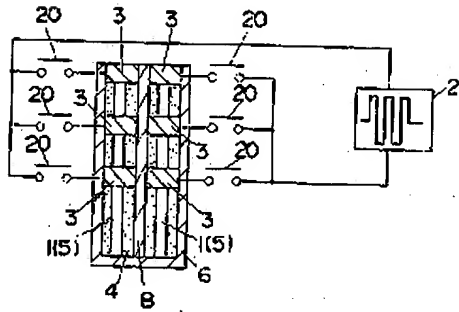
【図16】



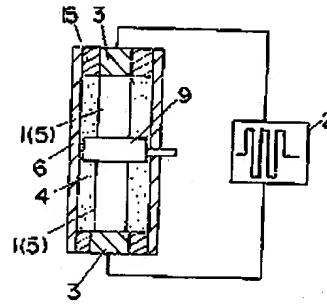
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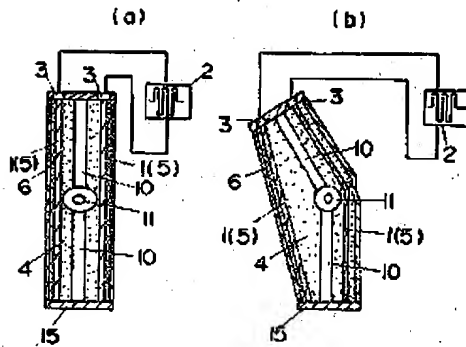
【図18】



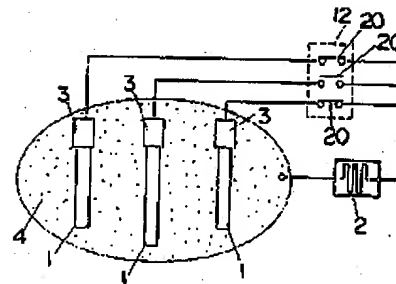
【図19】



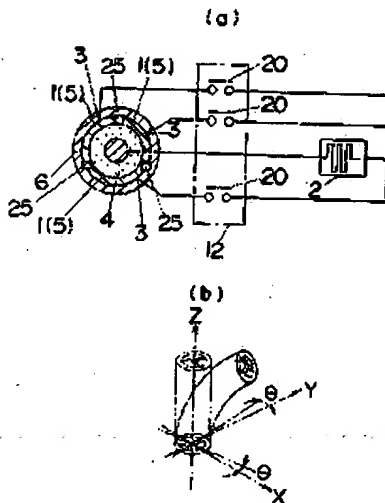
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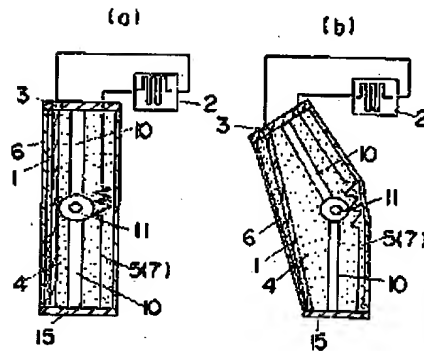
【図21】



【図22】



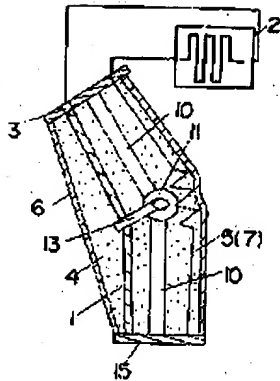
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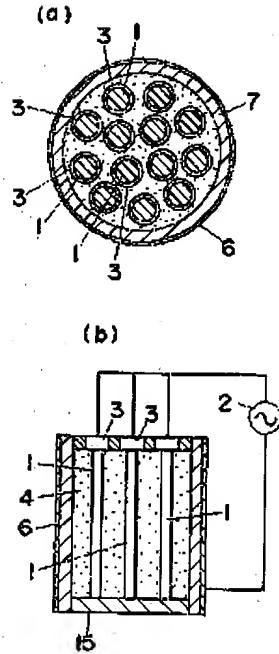
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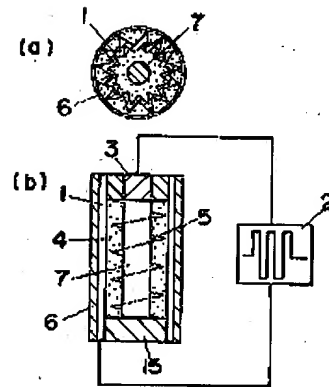
【図24】



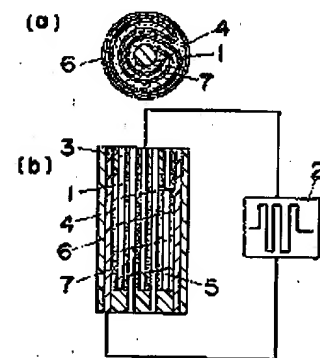
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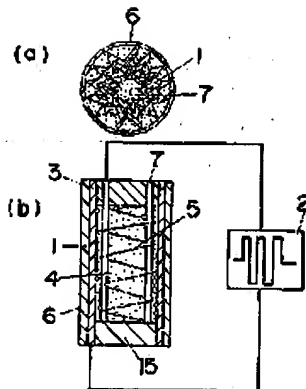
【図26】



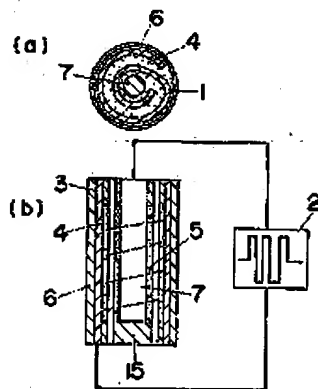
【図29】



【図27】



【図28】



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